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K	:	Karoo	Karoo
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D	:	Eastern Cape (Dohne)	Oos-Kaap (Dohne)
T	:	Transvaal	Transvaal
V	:	Free State	Vrystaat
W	:	Winter Rainfall	Winterreën

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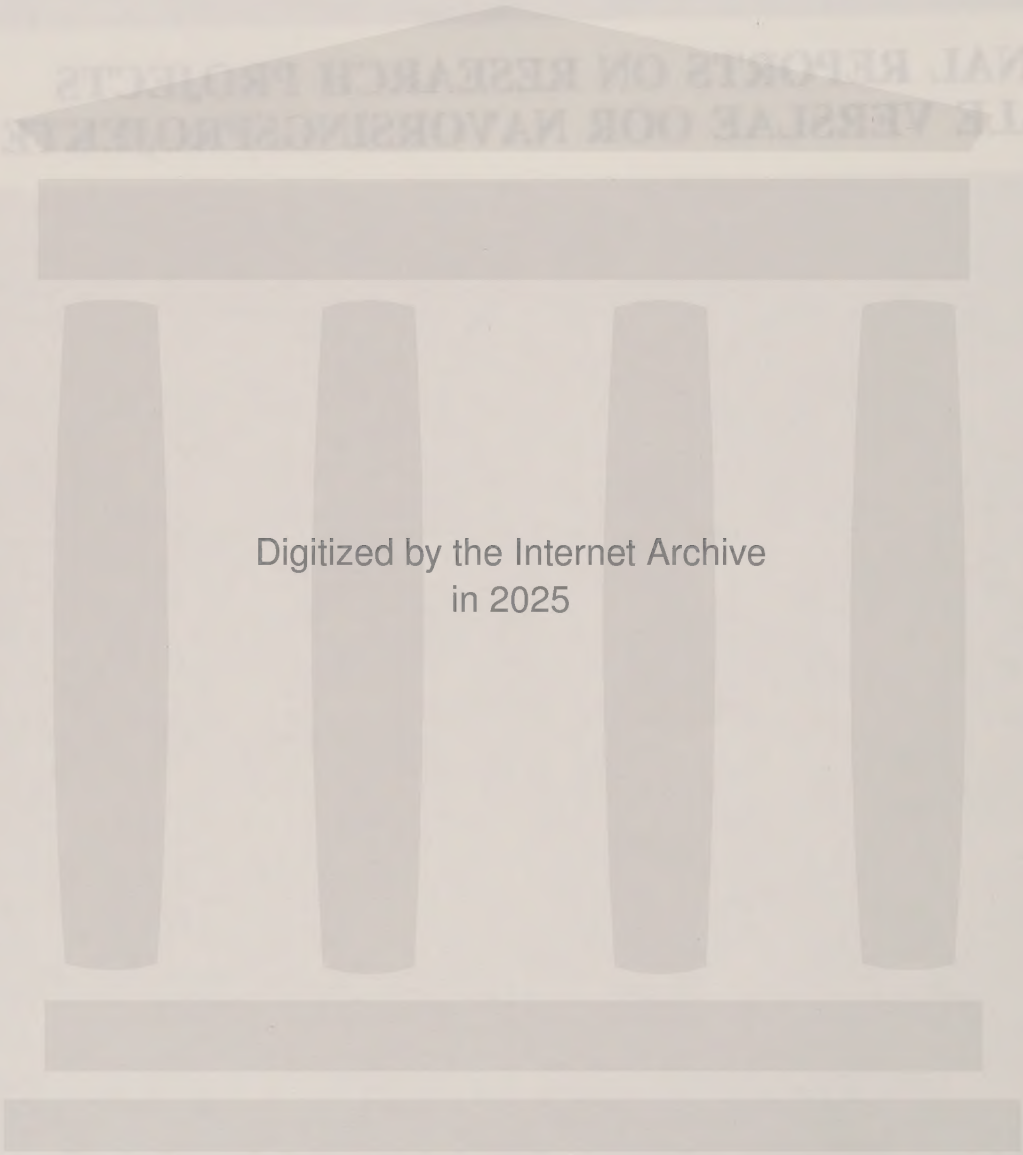

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PLANT PRODUCTION PROMOTION

AGRONOMY RESEARCH

Summer grain

MAIZE

• *Pathology*

GG.2111/19/4/5: TO DETERMINE THE EFFECT OF ROOT, STALK AND COB ROT ON THE YIELD OF MAIZE. 1981-1985

K.R. Chambers

The effect of time of inoculation of maize stalks and ears with *Diplodia zeae* on the severity of infection was investigated. There was no significant difference between stalk rot ratings resulting from inoculations at different times after mid-silk. Similarly, there was no significant difference in yield loss. This was explained in terms of vascular bundle distribution. Correlations between stalk rot ratings and yield indicated a non-significant relationship between these variables.

Ear rot decreased sharply with increase in time of inoculation after mid-silk and decrease in kernel moisture. A strong negative linear relationship existed between ear rot and yield loss. Yield loss was as high as 97% depending on time of inoculation. Plant attributes possibly involved in ear rot development were investigated. No significant levels of glucoside were recorded in the kernels and the correlation between ear rot and sugar concentration was non-significant. A significant correlation between ear rot and starch was recorded.

Small grain

WHEAT

• *Pests*

GG.2121/20/1/1: THE USE OF ECONOMIC THRESHOLDS FOR THE CHEMICAL CONTROL OF THE RUSSIAN WHEAT APHID, *DIURAPHIS NOXIA*. 1980-1985

F. du Toit

The main objectives of this study were: (1) to conduct damage assessment studies in order to quantify the yield losses caused by *Diuraphis noxia* to winter wheat in the eastern Orange Free State; (2) to formulate an economic threshold for use in the chemical control of the pest.

Additional studies were also carried out on the seasonal occurrence of *D. noxia*; the development of infestation during the wheat season and the effect of infestations on wheat quality.

Moericke trap catches of *D. noxia* alates revealed low flight activities during the summer and autumn months. Peak flight activities occurred during October and November. Initial infestations of wheat fields were probably mainly caused by alates migrating from volunteer wheat and wheat planted for grazing purposes. During October and November alates emigrated from the ripening wheat. No sexual forms of *D. noxia* were found during the course of the study.

The increase in the number of infested plants was highly correlated with time and a high correlation was also found between number of infested plants and number of aphids per plant.

Relatively short periods of exposure to infestations by *D.noxia* did not cause a significant reduction in yield. Yield reductions were mainly due to a reduction in the number of ears per unit area and a reduction in the kernel mass.

Colonisation by *D. noxia* of the two upper leaves of the wheat plants between growth stage 39 and 59 (Zadok's scale) has lead to a drastic reduction in yield. Chemical control at growth stage 31 prevented to a large extent the colonisation of the two upper leaves and thus subsequent yield losses. Infestation of *D. noxia* between growth stages 39 and 59 caused a reduction in the photosynthetic area of the wheat plant.

Economic thresholds were determined by two different methods. The first method was based on the the regression of time of infestation on yield of individual plants and also on the logarithmic increase in infestation. The second method made use of the regression of various infestation levels on plot yields. A mathematical model, making provision for variables such as the wheat price, control costs and infestation level, was constructed to calculate an economic threshold which could be utilised for making decisions on the economic feasibility of chemical control.

Infestations of *D. noxia* caused a reduction in the percentage flour extraction and heavy infestations led to a higher percentage protein in the kernels.

Protein and oil seeds

SUNFLOWERS

- *Nutrition*

GG.2132/05/1/3: THE EVALUATION OF LEAF ANALYSES AS DIAGNOSTIC TECHNIQUE IN SUNFLOWER NUTRITION. 1981-1986

H.L. Loubser, C.L. Grimbeek and Beulah Bronkhorst

Leaf samples were taken from fertiliser trials (GG.2132/05/1/1 and GG.2132/05/1/2) during the onset of anthesis. The topmost mature leaf and the 10th leaf from the top were sampled seperately. Apart from the N and P concentration in the topmost and 10th leaf the N and P ratio between the topmost and 10th leaf was determined as follows: Ratio = concentration of element in topmost leaf/concentration of element in 10th leaf.

The results indicated that there was no correlation between leaf P and seed yield because the P supply was sufficient even at low P levels. There was also no correlation between leaf N and seed yield but there was a significant correlation between leaf N ratio and seed yield that is described by the regression

$$Y = 5236 - 3761X \quad (R^2 = 0{,}7789)$$

where Y = seed yield in kg ha^{-1} and
X = nitrogen ratio.

This relationship between leaf N ratio and seed yield is regarded as a preliminary result. More data is needed to confirm the results of this study.

Other agronomy crops

COTTON

- *Upgrading*

TK.2141/07/1/3: BACK-CROSSINGS WITH COTTON. 1966-1980

C.G. Theron

One of the main problems related to cotton production along the Lower Orange River is its vigorous growth, with the result that cultivation practices, pest control and mechanical harvesting are hampered. Since dwarf types do not express their dwarf character in this area, while corrective fertilisation has proven ineffective, this study was undertaken to investigate the possible effects of introducing the Okra leaf trait. In addition, methods were applied to get an indication of the genetic structure of parents and the genetic stability of the recovered cultivars with the Okra leaf trait.

The introduction of the Okra leaf trait resulted in plants which were generally about 8,6 cm shorter than their normal leaf isogenic lines. In addition, Okra leaf plants were more open. The most striking result observed was that introducing the Okra gene into the genetic background of various cultivars on the whole coincided with earlier maturity, higher lint percentages and a slight reduction in fibre length, while no changes could be proved with regard to other fibre qualities.

Each of the above-mentioned alterations, except the reduction in fibre length, can be regarded as an advantage. Since it was also demonstrated that the genetic basis of fibre length is poligenic and mainly additive while variation still occurs, it should be possible to obtain genotypes with an acceptable fibre length by means of selection or additional back-crossing.

As regards stability and adaptability, the Okra leaf back-cross generally compares very favourably with the recurrent parent. The main difference is that the Okra leaf back-cross shows a higher degree of stability with regard to fibre strength. This fact is of extreme importance, since it seems to indicate that the fibre strength of the genotype does not fluctuate much.

The diallel analysis indicated that fibre characters and plant length are controlled by loci with mainly additive effects. Non-additive effects, however, also have an influence on yield, lint percentage and early maturity. Since selection for tolerance against *Verticillium* wilt and "rooidood" is very difficult it was concluded that back-crossing would be more effective than conventional methods of selection to obtain acceptable Okra leaf cultivars. The most significant contribution made by this study is the fact that it offers the most effective method to date of limiting over-vigorous growth of cotton along the Lower Orange River.

In later years it was found that the Acala characteristics showed too little in the Acala-Okra elite lines.

TOBACCO

• *Nutrition*

TK.2142/05/1/3: TRACE ELEMENT NUTRITION IN TOBACCO. 1973-1986
H.J. Boshoff

A trial with a control and two levels of boron and a control and two levels of calcium was carried out in a mixture of sand and soil in the greenhouse. After 9 weeks the leaves were harvested in bottom and top, dried, mass-measured and analysed for B, K, Ca and Mg.

All the plants in the pots that received no boron showed symptoms of boron deficiency. Of interest is the fact that the higher the calcium level the sooner total die-back of the growth occurred after the first symptoms. On the control this die-back took 15 days, for the Ca1 level 12 days and for the Ca2 level 6 days.

The lowest level of boron raised the boron content of the leaves from 5,5 ppm to 28 ppm. It is clear that we were looking for a visual deficiency symptom and that a hidden deficiency is to be expected between 5,5 ppm and 28 ppm boron.

Although boron depressed the uptake of calcium, calcium had no effect on the uptake of boron.

TOBACCO

• *Nutrition*

TK.2142/05/1/7: MAGNESIUM NUTRITION OF TOBACCO. 1980-1986
H.J. Boshoff

The use of magnesium sulphate and magnesium oxide and the effect thereof on the yield and quality of flue-cured tobacco was investigated on the sandy soils of the Friedenheim Experimental Farm near Nelspruit in the Eastern Transvaal Lowveld.

The most important conclusions that were made are as follows:

Applications of magnesium had no significant effect on the yield, price and income of flue-cured tobacco.

The magnesium content of tobacco was significantly increased with an application of magnesium sulphate at a rate of 25 kg Mg ha^{-1}. An application of 50 kg Mg ha^{-1} had no further effect on the magnesium content of tobacco.

The use of magnesium oxide had no effect on the magnesium content of tobacco.

It seems that sandy soils with an exchangeable magnesium content of more than 50 mg kg^{-1} have enough magnesium to meet the requirements of a flue-cured tobacco crop.

Justification was found for the application of magnesium on sandy soils with an exchangeable magnesium content of less than 50 mg kg^{-1}. The application must however be made in the form of magnesium sulphate and not magnesium oxide. The application is recommended as a top dressing within the first three weeks after transplanting and need not exceed a rate of 25 kg Mg ha^{-1}.

TOBACCO

• *Upgrading*

TK.2142/07/1/9: BREEDING OF *NICOTIANA TABACUM* CULTIVARS RESISTANT TO ROOT-KNOT NEMATODES. 1958-1986

A.P.F. Cornelissen

Due to the increasing importance and cost of combatting the root-knot nematode, *Meloidogyne* spp., it was decided to find sources of resistance to this pest in the early 1960's.

Initially attention was devoted to the naturally occurring *Nicotiana* spp. to supply the basic genes to overcome this problem. This led to *Nicotiana repanda* as a donor host, but this hybrid is infertile. To overcome this problem the technique of Burk was attempted but to no avail. In the meantime the USA released a nematode resistant variety, N.C. 95 and Schweppenthauser discovered a seedlot R83 in Zimbabwe with a lower infection-rating than commercial tobacco cultivars. K.J. Nuss produced a hybrid and expressed the idea that it should be possible to select resistant individuals.

This selection was done in sandbins in a glasshouse with nematode-infected soil. Each hybrid test consisted of 10 plants in the test. The plants with the lowest ratings were transplanted and seed harvested. The initial hybrids (N x R) and (R x N) were sibbed, selfed and back-crossed and subsequently hybridised with various flue-cured varieties to enhance the flue-cured character of the tobacco. The varieties that were included were Hicks, Hicks 76, Delcrest 202, A23 and TL33.

After several generations of haphazard results the existance of root-knot nematode races was established by Sasser in the U.S.A. Van Wyk in 1981/82 established that the root-knot nematode complex not only exist as a mixture of *Meloidogyne incognita* and *M. javanica* (Milne) but that several races of *M. incognita* also occur in the R.S.A.

After this break-through final selections were made and for three successive seasons the selections were planted to naturally occurring field populations in plots in a so-called double row technique. This technique consists of planting 2 rows of tobacco approximately 30-40 cm apart. The one row establishes an inplot susceptible control to indicate the severity of the nematode infection. The other row is the hybrid row from which the selections are made. If a severe infection of a susceptible plant is detected then the plant adjacent to this plant is screened. If a low rating-index is recorded the seed of this plant is retained for use in further hybridisation.

The final selections differ in their specific reaction to the nematode races in pure populations and also in some morphological respects, i.e. leaf number, plant length, leaf structure and number of days to flowering.

These breeding lines are designated KNST 1-16 with the Nicotiana Germplast Collection numbers ranging from SAN 1210-1255 and can be supplied on request by any interested party. The seed will be maintained and on every rejuvination, tested and only seed from low rating plants will be taken into stock.

TOBACCO

• *Upgrading*

TK.2142/07/1/11: A CYTOGENETIC STUDY OF F1 HYBRIDS BETWEEN *NICOTIANA REPANDA* AND *N. SYLVESTRIS*. 1981-1985

A.M. Esterhuizen and Kathe M.F.B. Brix

The chromosome pairing in two F1 hybrids between *Nicotiana repanda* (2n=8x=48) and diploid

(2n=4x=24) and tetraploid *N. sylvestris* (4n=8x=48) was studied during diakinesis. The occurrence of one to six bivalents (average 3 bivalents) in the hybrid between *N. repanda* and diploid *N. sylvestris* indicated a low pairing rate between the 24 *N. repanda* and 12 *N. sylvestris* chromosomes. One of these bivalents may even have been formed between *N. repanda* chromosomes, as indicated by the cross between *N. repanda* and tetraploid *N. sylvestris*. Meiotic studies of this hybrid revealed 13 bivalents instead of the expected 12 between the 24 *N. sylvestris* chromosomes.

Although the formation of bivalents between *N. repanda* and diploid *N. sylvestris* is low, a high frequency of partial or segemental pairing of chromosomes between these species was found. This is also indicated by the relative low average number of univalents (10 out of 36 chromosomes). The occurrence of this high frequency of partial pairing between the chromosomes of *N. repanda* and *N. sylvestris* indicates not only their relative close evolutionary relationship, but also suggests the possibility of partial substitution of *N. sylvestris* chromosomes by *N. repanda* chromosomes followed by a transfer of genes from one species to the other.

TOBACCO

• *Pathology*

TK.2142/19/1/2: INFLUENCE OF CROP ROTATION ON THE BLACK SHANK ORGANISM OF TOBACCO. 1977-1986

D.A. de Villiers

Wheat (*Triticum vulgare*), oats (*Avena sativa*), maize (*Zea mays*), cotton (*Gossypium hirsutum*), red chilli (*Capsicum annuum* var. *longum*), sunn hemp (*Crotalaria juncea*), babala (*Pennisetum typhoides*) and blue buffalo grass (*Cenchrus ciliaris*) were rotated with tobacco.

Wheat and oats were planted in the winter and tobacco in the summer of each year on the same plots. Blue buffalo grass was planted for one, two and three years in succession followed by a susceptible tobacco cultivar A23 to determine the disease index. Blue buffalo grass planted on the plots for two or three years in succession shows a significant decrease in the incidence of black shank disease. All the other annual crops, including the one year grass did not decrease the disease significantly.

TOBACCO

• *Pathology*

TK.2142/19/1/4: ALTERNATIVE HOSTS FOR THE BLACK ROOT ROT ORGANISM OF TOBACCO. 1980-1986

D.A. de Villiers

Crops commercially grown in rotation with tobacco were tested for susceptibility to a tobacco isolate of *Thielaviopsis basicola* and thus tested for the worthwhileness as a rotational crop. All crops showed infection varying from 10-80%. They were: tobacco (TL33) 80%, sunn hemp (*Crotolaria juncea*) 40%, cotton (*Gossypium hirsutum*) 20%, tomato (*Lycopersicon esculentum*) 20%, red chilli (*Capsicum annuum* var. *longum*) 40%, wheat (*Triticum vulgare*) 30%, oats (*Avena sativa*) 10%, babala (*Pennisetum typhoides*) 10%, maize (*Zea mays*) 10%, blue buffalo grass (*Cenchrus ciliaris*) 10%, pea (*Pisum sativum*) 60% and green pepper (*Capsicum frutescens*) 40%.

Weeds collected from tobacco lands were examined for the presence of the fungus. *Thielaviopsis basicola* was recovered from large thorn apple (*Datura ferox*), cocklebur (*Xanthium strumarium*), "turfbossie" (*Acalypha indica*), tall fleabane (*Erigeron floribundus*), flannes weed (*Sida cordifolia*) and dwarf marigold (*Schkuhria pinnata*), but not from bladder hibiscus (*Hibuscus trionum*), dandelion (*Taraxacum serothinum*) and sweethearts (*Pupalia lappacea*).

The conclusion is that certain crops should not be used as rotational crops and certain weeds eradicated in tobacco lands.

TOBACCO

• *Crop science*

TK.2142/30/1/4: SPACING AND TOPPING OF BURLEY TOBACCO. 1966-1982

M.P. Lamprecht

The effects of combinations of two plant spacings and four topping treatments on characteristics of burley tobacco (*Nicotiana tabacum* L. cv. B21 and CB31) were studied at Nelspruit from 1976/77 to 1979/80. The tobacco was planted in twin rows 25 cm apart with a 75 cm interrow spacing. The transplants were spaced 25 or 50 cm apart in the row, and the tobacco was topped to produce 320, 480, 640 and 960 thousand leaves/ha. With 25 cm spacing the number of leaves per plant (T) were 4, 6, 8 and 12 and with 50 cm spacing 8, 12, 16 and 24. Deeply topped tobacco (T4, T6 and T8) ripened early and was effectively whole-plant harvested.

Cultivar differences did not significantly alter treatment effects. Desirable yield, price, income and leaf quality were obtained from the 75/25 x 25 T8 treatment. Considerable seasonal differences occurred, however, with a significant influence on the results.

TOBACCO

• *Crop science*

TK.2142/30/1/7: CULTIVATION OF TOBACCO DIRECTLY FOLLOWING WHEAT UNDER IRRIGATION. 1976-1982

M.P. Lamprecht

The possibilities of a tobacco-wheat cropping system in order to increase effective soil utilisation under intensive cropping conditions on an Arcadia soil on irrigation farms in Western Transvaal were investigated.

Four combination treatments, i.e. tobacco planted on the ridge and in the furrow on uncultivated soil (stubble mulch) as well as on ploughed soil were investigated with tobacco following winter wheat as well as with tobacco following a winter fallow. Wheat was sown in winter on soil which had been fumigated with EDB. The ridges and furrows for planting tobacco were prepared before planting the wheat on uncultivated soil. Wheat received 100 kg N/ha as a topdressing. Immediately prior to the planting of tobacco, furrows and ridges were opened up by shallow cultivation during which 500 kg/ha of a 3:1:5 (26 S) fertiliser mixture was incorporated. Seedlings of the TL33 flue-cured tobacco cultivar were spaced 100x50 cm. After planting, normal procedures for weed, insect and disease control were practised.

The plots occupied permanent positions in order to measure the accumulative effects of treatments. The tobacco was increasingly infected by black shank over the seasons indicating a build-up of this soil-borne disease to the extent that even with a highly resistant cultivar, infection reached such proportions that certain plots had to be eliminated and only two of the four replications could be retained for statistical analysis.

Low yields, price and income were obtained especially in 1979/80 and 1980/81. Tobacco yields on soil planted to wheat were not necessarily inferior to yields on fallow soil. Neither were ridges, furrows, ploughing or non-cultivation considerably different. Low total alkaloid and high total reducing sugar concentrations were found during the first three seasons in the cured leaf.

In the fourth season acceptable levels of these quality attributes were found and tobacco of acceptable quality was produced. It has to be repeated that black shank incidence increases considerably especially on plots where tobacco was planted in furrows and the soil tended to become waterlogged after heavy rains or irrigation.

Reasonable wheat yields (3 600 kg/ha) were obtained and the combined income of tobacco and wheat significantly exceeded that of the tobacco grown alone.

TOBACCO

• *Water requirements*

TK.2142/31/1/1: THE INFLUENCE OF FLOOD AND SPRINKLER IRRIGATION ON THE YIELD AND QUALITY OF FLUE-CURED TOBACCO. 1968-1982

A. Streutker

The Arcadia soils in South Africa are in several aspects similar to the Australian "black earths", the

Indian ''regur'', pellic vertisols (FAO) and vertisols - pelloxerets (USDA). Fluctuation in rainfall (200-600 mm per growing season and 150 mm/3-5 days) and the low infiltration rate of these soils require surface drainage as well as supplementary irrigation for good tobacco production.

Between 1970 and 1981 twelve tobacco irrigation experiments were carried out. The treatments were furrow and ridge planting together with furrow and sprinkler irrigation. Results were obtained for seven years only because of hail and waterlogging during the other years.

During seasons of well distributed rainfall of a total of 300-500 mm there were significant differences in yield and quality of the tobacco crops. Yield increased by 15 % from furrow planting to ridge planting and another 12 % from furrow irrigation to sprinkler irrigation for ridge planting; a total increase from 2 100 kg/ha to 2 700 kg/ha. The total alkaloid content increased by 0,2 % from furrow to sprinkler irrigation and fluctuated over the years between 1,3 % and 2,0 %. The reducing sugar and total alkaloid ratio decreased to 10 under sprinkler irrigation and ridge planting, compared to 20 for furrow irrigation.

During years of well distributed average rainfall it is possible to produce a high yielding tobacco crop of an acceptable quality, which is worldwide a possible exception to the rule. However, during wet and dry years the black clay soils are marginal for the production of flue-cured tobacco.

TOBACCO

- *Water requirements*

TK.2142/31/1/2: IRRIGATION PRACTICES FOR ESTABLISHING TOBACCO PLANTS. 1976-1984.

A. Streutker

The aim of the research was to find an irrigation scheduling to produce a good stand of tobacco plants on ridges on black clay soils. The question was if it is really necessary to leave the newly planted seedlings in dry circumstances (without irrigation) for six weeks in order to develop a deep root system.

The trial treatments were:

1. Irrigation before and after the construction of the ridges (two treatments).
2. After planting irrigation for the first time after 0, 2, 4 and 6 weeks (four treatments).
3. Three planting dates: end of September, October and November (three treatments).

No conclusive results were obtained because rain interfered. In the meantime production of flue-cured tobacco on black clay soils moved to a great extend to the more sandy soils. On these soils it is probably necessary to irrigate before planting and at least one week after planting and onwards.

TOBACCO

- *Technology*

TK.2142/52/1/2: PRODUCTION LOSSES IN THE FIELD AND DURING HARVESTING, CURING AND GRADING OF FLUE-CURED TOBACCO. 1980-1986

J.G. Nel

Trials were conducted at the Tobacco and Cotton Research Institute at Rustenburg with the flue-cured cultivar *Nicotiana tabacum L.* cv. TL33 to determine the magnitude of losses that occur during harvesting, curing, storage and grading of the tobacco. During two successive seasons tobacco was produced on 2,2 and 1,1 hectares, respectively and subsequently cured in the Delanco model D1162 curer.

A further trial was conducted at Groblersdal where 0,8 ha tobacco was cured in a Delanco model D1060 curer. In the first trial at Rustenburg the 2,2 ha was known to have a problem of late N delivery, yielding tobacco of uneven body and ripeness. The crop was harvested in five primings by taking three to four leaves per plant per priming. In the second planting at Rustenburg on 1,1 ha the tobacco was harvested in four primings by taking five to six leaves per plant per priming. The acreage-curing capacity ratio in the Groblersdal trial was the same as that of the first Rustenburg trial. The tobacco was also reaped in five primings, taking three to four leaves per plant per priming.

It was concluded that tobacco produced on a soil with a late N delivery resulted in harvest losses of 17,5 %. Most of these leaves occurred during the first and last primings. The losses of the first priming were

due to over-ripe tobacco while unripe tobacco was responsible for the losses of the last priming.

The storage of tobacco at a moisture content of 11 to 12 % in boxes, lined with plastic bags, resulted in a reduction of breakages and handling losses in the order of 14 %.

Tobacco with a high sugar content was more resistant towards handling losses than tobacco with a lower sugar content. The oiliness of the tobacco also reduced breakages.

Over-ripeness of the tobacco is responsible for 22 % of the losses that occurred during grading, while green and sponged tobacco contributed to a 33 % loss.

Management is of primary importance to ensure an even growth and development of the tobacco in the field; to ensure that only tobacco of even ripeness is primed and that the loading density of each curing rack is even. By doing this production losses are limited. Two to four hectares of tobacco per curer, with a capacity of 162 curing racks will ensure a favourable barn-to-field ratio. It is recommended that not more than four leaves per plant per priming are taken and preferably less to ensure an even ripeness.

TOBACCO

- *Technology*

TK.2142/52/1/4: FERMENTATION OF AIR-CURED TOBACCO. 1981-1986
J.G. Nel

Fermentation is a controlled continuation of the curing process of air-cured tobacco. The purpose of fermentation is to obtain a specific aroma in the end product and to remove a light green glow of somewhat unripe tobacco without to much fungus growth.

The chemical oxidation process is influenced by the moisture content of tobacco, fermentation capacity of the leaves and the temperature of the tobacco stack. For a good controlled process a very even air movement through the stack is of the utmost importance. For that reason an open structure of ripe tobacco leaves is necessary. Physiological unripe tobacco with green patches will influence the process adversely.

During the fermentation process of normal tobacco measurements revealed the oxidation of phenolic compounds, a decrease of alkaloid, a change in reducing sugars and no change in the N-group compounds. The final fermented product is characterised by a high content of nicotine and neophytadine and a low content of furfiral and furfuryl alcohol.

The blending of unripe tobacco with tobacco of a good fermentation ability at a 1:1 ratio in a tobacco stack resulted in a satisfactory end-product with a low content of malic and citric acid.

TOBACCO

- *Chemistry*

TK.2142/53/1/1: FACTORS RESPONSIBLE FOR GREY OR SOUR TOBACCO. 1980-1986
J.G. Nel

Trials were conducted at the Tobacco and Cotton Research Institute at Rustenburg with the flue-cured cultivar *Nicotiana tabacum* L. cv. TL33 using various levels of irrigation, N fertilisation and chlorine topdressings in order to induce symptoms on flue-cured tobacco that is related to the physiological disorder known as grey tobacco. This tobacco also frequently has an offensive sour linoleum aroma.

Treatments of 600, 500 and 400 mm of accumulated irrigation was applied during the growing season. In addition to the 600 kg of 2:3:4 (27) fertiliser mixture per hectare some treatments received a further topdressing of 10 g limestone ammonium nitrate per plant whereas no L.A.N. was applied to others. A chlorine topdressing of 25 g NaCl per plant was applied to some treatments whereas others received none. After curing the tobacco samples were subjectively evaluated for the presence of a linoleum aroma by using a sliding scale from 10 to zero. Samples were taken for chemical analyses and the results were finally statistically analysed.

Evidence was given that not one, but in fact two physiological disorders are to the point; a linoleum and a grey tobacco. Linoleum tobacco was invariably associated with conditions of high levels of irrigation and low levels of N fertilisation or of leaching of nitrogen. The alkaloid content of the tobacco is low and the relative sugar/alkaloid ratio high. The C/N balance in the plant is disturbed and the pale appearance of

the tobacco indicates a dilution of quality. Grey tobacco is invariably associated with a high chlorine content. Evidence was also given that toxic concentrations of Fe and Mg together with high Cl levels, could result in an imbalance of the nutrient status of the plant resulting in the grey slaty appearance of the tobacco.

TOBACCO

• *Chemistry*

TK.2142/53/1/2: FACTORS RESPONSIBLE FOR THE PRODUCTION OF RED SPONGE TOBACCO. 1979-1981

J.G. Nel

Two trials were conducted at the Tobacco and Cotton Research Institute at Rustenburg with the flue-cured cultivar *Nicotiana tabacum L.* cv. TL38. Various levels of nitrogen fertilisation and curing regimes in order to evaluate the effect of these variables on the development of a physiological disorder known as red sponge tobacco, were used. This disorder must, however, be distinguished from red scorched tobacco and "cherry red" tobacco, the latter being induced by the presence of nornicotine.

To the basic fertiliser application of 200 kg 3:1:5 (38) mixture per hectare in the first trial the following amounts of limestone ammonium nitrate (L.A.N.) were supplemented as a topdressing: 0, 80, 140 and 200 kg/hectare. This totaled respectively, to 25,4; 47,8; 64,8 and 81,4 kg N/ha. Recommended procedures for subsequent cultivation, curing and grading of the tobacco was followed.

With an increase in the levels of N fertilisation the results revealed that:

(a) The yield (kg/ha) of tobacco increased.
(b) A shift occurred in the style of tobacco that was produced, at the expense of the more natural and usable tobacco's.
(c) The percentages of red sponge and unmarketable tobacco increased from 30 to 37 % and
(d) the average price of the tobacco decreased from 262 to 201 cent/kg.

The highest average income per hectare was obtained at the 47,8 kg N/ha level. The lower and higher levels of N applications resulted in a decrease in income.

Leaves harvested from the bottom stalk positions were less subject to red sponge tobacco than the heavier bodied leaves from the upper stalk position. With an increase in N fertilisation the bottom leaves showed a slight increase in red sponge tobacco as opposed to a more drastic increase in the leaves harvested from the top of the plant. With an increase in the levels of N fertilisation the alkaloid content increased but the sugar percentages were lowered. The sugar: alkaloid ratio decreased progressively.

In another experiment where the tobacco was fertilised, cultivated and harvested according to recommended procedures, half of the primings were subjected to a forced curing schedule while the rest was cured according to recommended procedures. In the forced curing schedule the leaves were cured at relatively high temperatures (45 to 55 °C) with restricted ventilation, whereas the leaves still contained an appreciable amount of water. In the recommended curing schedule the lamina of the leaves were dried at temperatures below 40 °C with open ventilations. After completion of both curing schedules by drying the midribs at elevated temperatures up to 70 °C the tobacco was subsequently graded according to recommended procedures.

The forced curing schedule also resulted in a shift in the style of tobacco, at the expense of the more natural and usable tobacco's. The percentages red sponge and unmarketable tobacco's increased from 10 to 29 % while the average price decreased from 302 to 214 cent/kg.

Finally it was demonstrated in a laboratory experiment that certain amino acids developed a red colour with O-benzoquinone, whereas others showed a red-brown or brown colouration.

TOBACCO

• *Chemistry*

TK.2142/53/1/3: FACTORS RESPONSIBLE FOR THE FLAT APPEARANCE AND GRAINY TEXTURE OF BULK-CURED FLUE-CURED TOBACCO. 1981-1983

J.G. Nel

The colour, shape and body of flue-cured tobacco are important quality properties. In addition there

are other important secondary properties like maturity and ripeness. The concepts of maturity and ripeness at the time of harvest are very close and both have an influence on the texture and elasticity of the tobacco after curing. Maturity is a function of the physical growth status of the leaf at the time of harvest and is determined by the amount and time of N fertiliser and irrigation applications. Ripeness on the other hand is a function of the chemical status of the leaf at the time of harvest and is determined by the starch/ nicotine ratio. Only when maturity and ripeness coincide it is possible to cure tobacco of a high quality and open grainy texture.

Bulk curing of flue-cured tobacco implies the placing of the leaves at a certain bulk density in curing racks. The side-ends of the racks exert a certain amount of pressure across the width of the leaves. This resulted in a flat appearance of the tobacco after curing. Tobacco technologists, buyers and manufacturers associate this flat appearance with close-grained tobacco. It was the aim of this study to establish the relationship between various bulk densities of the tobacco leaves in the curing racks and the texture of bulk-cured flue-cured tobacco. The optimal loading density of the leaves in a curing rack was also determined.

Curing trials with *Nicotiana tabacum L.* cv. TL33 were undertaken. The leaves were primed at the optimal harvesting maturity and packed in curing racks at bulk densities ranging from 21,2 to 127,3 kg per m^3 of curing capacity (i.e. 10 to 60 kg leaf per standard curing rack). After curing the tobacco was evaluated for the development of a flat appearance and grainy texture.

With an increase in bulk density the percentage of tobacco of which the leaf area was more than 50 % flat increased while the percentage decreased for leaves which were less than 50 % flat. With an increase in bulk density the percentage of tobacco with an open grainy texture and the price thereof, decreased. There existed an inverted significant relationship between the flat appearance of the tobacco and the open grainy texture and price. The optimal bulk density ranged from 35 to 40 kg leaf per standard curing rack.

TOBACCO

• *Chemistry*

TK.2142/53/2/1: THE DETERMINATION OF INDIVIDUAL ALKALOIDS IN TOBACCO. 1982-1983

J.G. Nel

In order to find a suitable method, on a time and cost basis, for the routine analysis of nornicotine in tobacco samples, two techniques of individual alkaloid determinations were compared, *viz* a thin layer chromatography (HPTLC) method of Hodgson *et al.* (1965) and a gas chromatography (GC) method as described by Bush (1972).

Seven different alkaloids could be detected in one of the samples that were analysed according to the HPTLC-technique while the GC-method could only detect nicotine and nornicotine. The differences in nicotine and nornicotine percentages of three selected samples, analyses according to the procedures of the two techniques are within the limits of a 10 % variation and compared very favourably.

For the routine qualitative analysis of nornicotine in tobacco samples the HPTLC-method is however recommended.

TOBACCO

• *Chemistry*

TK.2142/53/2/2: NORNICOTINE STATUS OF FLUE-CURED TOBACCO BREEDING LINES. 1981-1985

J.G. Nel

Genotypes which convert nicotine to nornicotine are a constant problem in flue-cured tobacco cultivar development programmes. Because cultivars with high levels of nornicotine exhibit undesirable smoke flavours, breeding lines must be screened to eliminate converting genotypes prior to their release as cultivars.

Since nornicotine leads to the formation of a characteristic red colouration of the tobacco, known as "cherry red", tobacco samples with a red colour varigation were collected from two tobacco co-operatives.

By using thin-layer and gas chromatographic techniques of analysis it was demonstrated that not all tobacco with a red colouration contains high levels of nornicotine.

Furthermore it was also demonstrated that by identifying nicotine converter plants in the field and by eliminating the seed of these plants the percentage converters in a subsequent population could be reduced considerably.

TOBACCO

• *Chemistry*

TK.2142/53/2/3: CHANGES IN SOME PHYSICAL AND CHEMICAL PROPERTIES OF FLUE-CURED TOBACCO DURING LATE FIELD GROWTH. 1978-1986

J.G. Nel

Flue-cured tobacco leaf samples, harvested according to stalk position, were taken at weekly intervals during the late field growth period from plants grown on black clay soil plots that received a total nitrogen fertiliser application of 30 (low), 40, 50, 60 and 70 (high) kg N per hectare. After length and mass measurements the fresh leaf samples were directly freezed and then freeze-dried. The ground samples were analysed for starch, total reducing sugar, total nitrogen and total alkaloids. Colour measurements were made on the dried ground samples while the respiration rate was measured on fresh green leaf discs directly after harvest.

From 7-13 weeks after transplant the length and dry mass per leaf increased considerably while the respiration rate declined to a minimum. During the same period the intensity of the yellow colour increased rapidly while the green colour declined gradually. Accompanying the decline in respiration rate the concentration of total reducing sugars also declined rapidly while this period was characterised by a marked increase in the starch content of the leaves. The total nitrogen concentration in the leaves dropped considerably while the total alkaloids reached a maximum value at the time of harvest.

When the level of nitrogen fertiliser applications were increased it resulted in a significant increase in the moisture content, the dry mass per leaf, the length, respiration rate, intensity of the green colour and brightness of the leaves. Similarly the percentages of total reducing sugar, total nitrogen and total alkaloids increased while the starch content declined considerably.

The percentage moisture in the leaves declined with ascending stalk position while cutters and leaves had the highest dry mass per leaf and were also the longest. The respiration rate was highest in the lower leaves and declined towards the higher stalk positions. The green colour intensity and brightness increased with ascending stalk position while the yellow colour intensity decreased correspondingly. The starch content increased rapidly with ascending stalk position, indicating that the upper leaves are the major storage organ for this compound. The leaves of the lower stalk positions were highest in total reducing sugars, while the nitrogen and alkaloid concentrations were highest in the upper leaves.

If a too heavy nitrogen application is applied in order to increase the yield per hectare, the C:N balance in the plant is disturbed resulting in an over-utilisation of the available energy for the reduction of the excess nitrate N to amino N. The result is that insufficient energy is available for the build-up of starch reserves. This leads to a disturbance of the sugar:alkaloid ratio in the cured tobacco and an accompanying decrease in quality. If, however, too little nitrogen fertiliser is applied physiological ripeness of the leaves will be induced before maturity has been reached and a sufficient complement of alkaloids has been accumulated. The result is a loss in yield and quality because the sugar:alkaloid ratio of the cured tobacco is too high.

To produce good quality flue-cured tobacco it is essential that the correct amount of nitrogen fertiliser is applied which can only be accomplished by preceding soil analysis. It is also important that the full complement is applied early during the growth period when the demand for nitrogen is high. The nitrate N in the soil should be depleted by the time of topping.

In a second experiment leaf samples from the third priming of *Nicotiana tabacum*L. cv. TL33 were collected at various stages during the curing process in a bulk-barn. These samples were mass-measured, freeze-dried, ground and analysed for various biochemical changes during the yellowing and drying phases of the tobacco.

The curing of flue-cured tobacco is a catabolic process and is characterised by a loss in dry matter, moisture and a decrease in the respiration rate. Chemically, significant changes occur in the dinamic group of components such as a decrease in the starch content and a corresponding increase in the total reducing sugar percentage. The nitrogenous compounds underwent less changes except for a slight increase in the amino acid content.

HORTICULTURE RESEARCH

Tuber crops

POTATOES

• *Pathology*

GS.2411/19/1/1: THE FORECASTING OF POTATO LATE BLIGHT EPIDEMICS. 1972-1986
D.J. Theron

From 1972 a late blight forecasting service was developed and used for the Eastern Transvaal Highveld and the Natal Regions. The Eastern Free State was included in the 1984/85 season. During the potato growing seasons weather conditions in these regions were monitored and blight warnings based on available weather data were issued to the potato growers through written and radio forecasts.

Relatively dry summers were experienced for the last three years, during which late blight was not a problem in potato production areas. Natal however experienced a wetter (85/86) summer and the late blight disease assumed a more normal pattern of outbreak and spread in the potato fields.

The late blight forecasting service had a few shortcomings: the weather stations were not representative of the regions in which they were situated; there was also no daily communication between the meteorological stations and the forecasters; weather data were recorded at 08h00 only, so humidity at 14h00 was unknown which is a critical figure in the forecast. The lapse of time between the time when weather data were received by the forecasters at the Institute, calculations made and the forecast sent to the potato growers, after a favourable period for blight development, was not acceptable.

These limitations affected the accuracy of the forecasts, although during times when there was clearly no danger of blight outbreaks a service in which growers were informed that spray programmes with fungicides were unnecessary, assisted the grower in reducing production cost to some extent.

Vegetables

VINE CROPS

• *Pathology*

GS.2426/19/1/1: VIRUS DISEASES OF VINE CROP VEGETABLES. 1982-1985
F.W. van der Meer

Cucurbit crops in South Africa are being seriously affected by a virus disease which causes the plant to be stunted, the leaves to display symptoms of chlorotic mosaic, dark green blisters and malformation, and fruit if produced to be malformed. The potential to grow cucurbits throughout the growing season cannot be realised because of this virus disease. The predominant causal agent is a flexuous rod-shaped virus 750 nm long, which produces pinwheel, bundle and tubular inclusions within the plant cell. Characterisation studies show the virus to have a fairly limited host range, a thermal inactivation point of 50 to 55 °C, a dilution end point of 10^{-4} to 10^{-5}, longevity *in vitro* of 5 days, a single viral coat protein of molecular mass 36 000 daltons, a single stranded RNA core of molecular mass approximately $3x10^6$ daltons and a sedimentation coefficient of approximately 150 S. The virus was non-persistently transmitted by the aphid *Myzus persicae* and was not seed-transmitted. These characterisation studies identify the virus as a member of the potato virus Y group and specifically a member of the watermelon mosaic virus complex.

Serological comparisons made with antiserum to watermelon mosaic virus 1, watermelon mosaic virus 2 and watermelon mosaic virus M identified the virus as watermelon mosaic virus M. It was found that watermelon mosaic virus M is the dominant virus strain in all the main cucurbit producing areas of South Africa surveyed. Watermelon mosaic virus 2 was identified by means of diagnostic host range studies and serological comparisons and was isolated in the Western Cape only.

No resistance to watermelon mosaic virus M could be found in South African cucurbit cultivars. However, resistance to this virus was found in *Citrullus ecirrhosus, Luffa cylindrica, Cucumis metuliferus, Coccinia sessilifolia* and several wild *Citrullus lanatus* species.

Flowers and ornamental plants

PROTEAS

• *Crop science*

ORCHARD CULTIVATION PRACTICES OF PROTEAS. 1978-1986

G.J. Brits

This study concentrated on the extension of the harvesting period in *Leucospermum* by delaying its flowering time. Pruning of the immature inflorescence by hand, or chemically with ethephon sprays, were shown to be practical means of extending the harvesting period of several new pincushions released by the Vegetable and Ornamental Plant Research Institute.

This is a partial solution to the important problem of the short annual flowering and marketing period in *Leucospermum*, which results in serious overproduction during September to mid-November. Chemical pruning was found to be more practical, but also more risky, than hand debudding. The correct concentration, application time and method for ethephon treatment of plants were determined.

By combining cultivars specially selected for favourable reaction to ethephon treatment, improved cold storage procedures, and possibly the late production of pincushions in cooler areas, the overseas marketing of pincushions during the Christmas season and even beyond has now become feasible.

A set of guidelines and methods for ordinary pruning of proteas was compiled. A colour illustrated pamphlet on the subject is presently in press.

CUT FLOWERS

• *Physiology*

GS.2433/03/2/2: EMBRYO CULTURE STUDIES ON BULB FLOWER CROPS: *ORNITHOGALUM*. 1984-1986

J.G.J. van Rensburg

A light microscopy study was done on the ontogeny of the pollen, the morphology of the mature ovule, fertilisation and the development of the seed of *Ornithogalum dubium* Houtt. An experimental study was also carried out to determine the effect of the sucrose concentration, growth regulators (benzyl amino purine, indole acetic acid and gibberellic acid) and coconut endosperm on the *in vitro* growth of *O. dubium* embryos of four developmental stages.

An unusual feature in the ontogeny of the microspores was observed - after the release of the spores from the tetrade, they appear folded and empty with cell wall information commencing during this stage. The spores acquire a normal appearance during later stages of their development as they become filled with cytoplasm. Mature pollen grains consist of two cells.

The ovule of *O. dubium* is anatropic and bitegmic. The nucellus is crassi nucellate with a nucellus cap and a prominent hypostase. The embryo sac development is of the Polygonum type (Maheswari 1950), with the secondary nucleus positioned micropylar to the antipodal cells. The synergids are large cells, each containing a prominent filiform apparatus (FA). Fertilisation occurs 24 h after pollination and is porogamic. The pollen tube enters the egg apparatus by growing into the micropylar end of the FA of the degenerate synergid, where its contents is released. The first mitotic division of the zygote occurs approximately 72 h after pollination. This study indicates that the synergids do not only play an important role during fertilisation, but they are possibly involved in the nutrition of the embryo during embriogenesis.

It was found that the sucrose concentration of the culture medium plays an important role during the *in vitro* embryogenesis of *O. dubium*; young embryos require a high, while mature embryos require a low sucrose concentration. Growth regulators at a high concentration inhibited growth of embryos, while low concentrations stimulated growth. An interaction exists between the sucrose concentration and growth regulators. Coconut endosperm and high sucrose concentrations had the same beneficial effect on the growth of pro-embryos.

Pome and stone fruits

APPLES

• *Pathology*

VV.2441/19/1/3: STUDIES CONCERNING THE REQUIREMENTS FOR ESTABLISHING APPLE FRUIT INFECTION BY *VENTURIA INAEQUALIS*. 1981-1987

W.F.S. Schwabe

Scab is the most important apple disease. The causal fungus, *Venturia inaequalis*, attacks leaves, blossom parts and fruit. To achieve the most economic and effective scab control knowledge of the epidemiology of the disease is necessary. A study was conducted to determine the requirements for fruit infection during all stages of development. Greenhouse and field trials were carried out.

In greenhouse studies, potted apple trees with fruit in various stages of development were inoculated with conidia of *V. inaequalis*, exposed to different durations of wetting, and rated after a suitable incubation period for the severity of scab infection on the fruit. Wetting duration required for infection increased with increased age of the fruit. At high inoculum levels, fruit showed light (approximately 2%) infection at infection indices (hours of wetting x mean temperature °C) of 120, 260, 370, 455, 525 and 590 when inoculated 1, 5, 10, 15, 20 and 25 weeks after full bloom, respectively. A curve describing this relationship increased exponentially with time and was linearised with a square root transformation of fruit age. When the duration of wet periods was adjusted to account for changes in fruit susceptibility with age, it was possible to develop a linear regression model relating hours of wetness at 9,3 °C to 20,0 °C to the severity of scab infection on the fruit.

Equations developed under greenhouse conditions were tested under field conditions. Scab control measures were successfully applied against fruit infection in accordance with recorded fruit infection indices.

APPLES

• *Pathology*

VV.2441/19/1/4: IMPLEMENTATION OF AN APPLE SCAB WARNING SERVICE. 1981-1987

W.F.S. Schwabe

Scab is the most important apple disease. Control measures for this disease are very costly. To achieve effective economic scab control, an apple scab warning service will be of great advantage. Therefore a study was conducted to implement such a service.

Different aspects which form part of a warning service were investigated. A method was developed to monitor ascospore discharge in different apple and pear growing areas of the South-western Cape. This so-called "bubble" method was highly effective and much more sensitive than the widely used spore trap methods. Since ascospore discharge has to be monitored for a great number of different areas, much work is envolved.

Attempts were made to develop mathematical models to predict ascospore discharge according to climatological information. High r^2 values were obtained when the data from each overwintering site and each year were subjected to linear-regression. However, when the data for all sites and years were pooled, r^2 values decreased from a mean of 95% to 74%. The number of cumulative degree-days for 50% and 90% ascospore discharge were approximately 500 and 900 respectively, compared to estimates of 250 and 477 degree-days based on a scab ascospore maturity model developed in New Hampshire, U.S.A. Apparently an environmental factor, possibly moisture, decreased the rate of ascospore maturation in South Africa.

Finally this experimental model was not implemented in the South African apple industry. At present the original developed "bubble" method is used successfully locally.

Various warning stations equipped with a variety of recorders for monitoring natural scab infection periods were operated. Collected information was used by the apple industry to adapt scab control programmes accordingly. The efficiency of different recorders was evaluated.

At present sufficient information is available so that the apple scab warning service can be managed effectively by the apple industry itself. This service forms part of the integrated scab management approach. Hereby scab-free fruit can be produced cost-effectively.

• *Pathology*

VV.2441/19/2/1: BACTERIAL BLISTER BARK OF APPLES. 1983-1987
E. Lucience Mansvelt

The present investigation has indicated that a heterogeneous group of strains of *Pseudomonas syringae* pv. *syringae* van Hall causes pear blast, and blister bark and blight of fruit spurs of apples in South Africa. Some of the pathogens were characterised as forms intermediate between *P. syringae* pv. *syringae* and *P. syringae* pv. *morsprunorum* (Wormald) Young *et al. P syringae* pv. *papulans* (Rose) Dhanvantari, the causal organism of apple blister spot was not found.

A resident phase of pathogenic *P. syringae* pv. *syringae* was detected on apparently healthy apple and pear buds, leaves, blossoms and fruit. The pathogen was sheltered inside buds during both the growing and dormant periods of the hosts. In early spring, pathogen populations on inner bud scales and primordia increased, providing inoculum for subsequent epiphytic colonisation of blossoms and leaves. Higher populations of *P. syringae* pv. *syringae* usually occurred on pear than on apple blossoms and fruit. Yellow-pigmented, non-pathogenic bacteria present in apple samples might have suppressed or masked the presence of the pathogen. Resident populations fluctuated greatly on apple and pear leaves but higher numbers generally occurred during the 1984/85 season than the drier 1983/84 season. The resident phase of the pathogen probably accounts for the appearance of apple blister bark and pear blossom blast in orchards with no history of these diseases. Furthermore, if symptomless buds cut from apparently healthy budwood harbouring *P. syringae* pv. *syringae* are grafted onto rootstocks, the diseases can spread to new plantings.

Scanning electron microscopy indicated that *P. syringae* pv. *syringae* entered pear leaf tissue through the open base of trichomes and through microscopic fissures in depressions of the cuticular layer. Stomata were not important. *P. syringae* pv. *syringae* entered pear leaf tissue through natural openings. The pathogen was present on all parts of inoculated flowers, but most extensive colonisation occurred between papillae on stigmas and on the surface of nectariferous tissue within the receptacle.

• *Pests*

VV.2441/20/1/2: BIONOMICS OF SNOUTBEELTES ON APPLES. 1981-1987
B.N. Barnes

The vine snoutbeetle, *Phlyctinus callosus* Boh., has been a pest on fruit in South Africa since before the turn of the century. Since the late 1960's it has developed into a serious pest in apple and nectarine orchards in the South-western Cape, where it is currently rated the most difficult pest to control. At the time this facet was registered, very little was known about its bionomics or behaviour in fruit orchards, and growers urgently needed a reliable monitoring system and an improved control strategy.

In laboratory studies, the incubation period of the eggs was found to be 7,0 days at 25 °C. Laboratory-reared larvae required from 4 to 11 instars to complete development. Mean larval and pupal durations at 20 °C were 99,9 and 14,0 days, respectively. The use of head capsule widths to determine the age of field-collected larvae was complicated by the overlapping of head capsule widths of successive instars.

In orchard studies, females preferred to oviposit in confined spaces in moist plant tissue. Most eggs in the orchard were laid in weeds and grasses in the cover-crop. Females preferred certain species of plants for oviposition.

The dispersion patterns of eggs, larvae and pupae in the orchard were contagious. Larvae did not appear to disperse to any extent after entering the soil. Most larvae and all pupae occurred in the upper 10 cm of the soil.

Different life cycles of *P. callosus* were found on two different farms. Two generations occurred per year on one farm and only one on the other. Evidence suggests this is due to a combination of climatic factors and differences in certain cultural practices between the two farms. The spring generation adults emerged from the soil from October to November, and second generation adults from February to May. Oviposition increased during two to three periods in the year. Peak larval populations occurred from July to October (pupae - September to November), and again from January to April (pupae - February to May) where the second generation occurred.

Most fruit damage by the adults occurred in November. The sudden decrease in fruit feeding in December appears to be due to a combination of a thickening in the fruit's wax cuticle and the mandibles on the adults becoming blunt owing to the wearing effects of feeding.

The frass of the adults contains an attractant that is highly attractive to adults of both sexes.

Six natural enemies of *P. callosus* were recorded. Those thought to exert the greatest influence on orchard populations were a mymarid egg parasite, *Gleruchus* sp., and a trombidiid mite species on the adult. Guinea fowl had an insignificant impact on *P. callosus* populations in deciduous fruit orchards.

A monitoring system to detect the emergence of adults from the soil was devised, based on the placement of cone traps over trap weeds on the orchard floor.

An improved management strategy is suggested, incorporating the application of insecticide sprays to the cover-crop to reduce the number of ovipositing females. Alternative insecticides to the synthetic pyrethroids, which have adverse effects on beneficial species in the orchards, are suggested. The use of trunk barriers to prevent adults gaining access to the trees should be effective, provided growers prune the trees and manage the cover-crop correctly.

APPLES

• *Crop science*

VV.2441/30/3/3: TRAINING SYSTEMS FOR APPLES ON DWARFING ROOTSTOCKS. 1972-1986

O. Bergh

Golden Delicious, Granny Smith and Starking trees were trained to four different training systems, *viz* vase, pyramid, slender spindle and spindle bush on three different rootstocks namely Merton 793, MM106 and M26 rootstocks. A split plot design consisting of three main treatments (rootstocks) and four sub-treatments (training systems) was chosen for the trial. The trees were planted during 1972 and started bearing during 1975.

Results for the period 1976-1986 showed that the more dwarfing rootstocks namely MM106 and M26 did not result in an improved production of fruit when planted at 1 500 trees per hectare than trees on M793 rootstocks. Although MM106 and M26 rootstocks are popular in Northern hemisphere apple production areas these rootstocks cannot be recommended for South African conditions and soils of medium potential. The severe dwarfing habit of these rootstocks and reduction in vigour caused a marked increase in the incidence of sunburn especially in the Granny Smith cultivar.

Although the different training systems did not cause marked differences in the production of trees, it was clear that the vase shaped trees gave consistently higher yields than the pyramid-, slender spindle- and spindle bush training systems. These differences were due to the relative drastic pruning which was required to train the latter trees to the required shape. The different training systems did not have a marked effect on the incidence of sunburn and it was evident that the systems would have to be changed drastically to reduce the incidence of sunburn. The pyramid and spindle type of training systems are extremely popular in Northern hemisphere countries but cannot be recommended for South African conditions unless the systems are modified drastically. Such drastic pruning would also reduce tonnages and the method would have to be compared with other methods aimed at reducing sunburn, i.e. overhead cooling and protection by means of shadecloth.

APPLES

• *Technology*

VV.2441/52/1/1: INFLUENCE OF GAS COMBINATION DURING CONTROLLED-ATMOSPHERE STORAGE ON THE KEEPING QUALITY OF APPLES. 1978-1986

A.B. Truter

In a study extending over a period of eight years Golden Delicious, Starking and Granny Smith apples from the Elgin area, harvested at optimum maturity, were stored under controlled-atmosphere conditions for

seven to nine months. After harvest, fruit of the cultivars Golden Delicious, Starking and Granny Smith were treated with suspensions containing 1 000 mg dm^{-3} benomyl plus 500, 2 000 and 2 500 mg dm^{-3} diphenylamine (DPA), respectively. Treated fruit were cooled to a temperature of -0,5 °C (0 to 0,5 °C for Granny Smith) in 27 m^3 gas-tight cold stores within 48 hours of picking. By using a propane burner and an activated carbon scrubber, gas concentrations in the cold stores were modified as follows within 24 hours after sealing:

1 % O_2 + O, 1 and 2 % CO_2
1,5 % O_2 + 1,5 % CO_2
2 % O_2 + O, 1 and 2 % CO_2
3 % O_2 + 3 % CO_2

After storage the fruit were kept at 20 °C for seven days before quality parameters such as flesh firmness, skin colour, total soluble solids, acidity, incidence of superficial scald and core flush were evaluated.

Apples of all cultivars had the best quality after storage at 1 to 2 % O_2 although the effect on the quality of Granny Smith apples was not prominent. The most effective carbon dioxide concentrations were 1 % to 1,5 % (Golden Delicious and Starking) and 0 % (Granny Smith). During seasons when Granny Smith apples had a high potential for the development of core flush, CO_2 in the atmosphere increased the incidence of this disorder. Higher O_2 and CO_2 concentrations (2 to 3 % O_2 and 2 to 3 % CO_2) caused softening and yellowing of the apples. Acid content was maintained better at low gas concentrations. In Starking apples the incidence of superficial scald was controlled by an atmosphere containing 1 % O_2 and 1 % CO_2.

APPLES

• *Chemistry*

VV.2441/53/1/1: QUANTITATIVE CHEMICAL ANALYSIS OF APPLES BY MEANS OF THE SCANNING ELECTRON MICROSCOPE AND ENERGY DISPERSIVE X-RAY ANALYSIS. 1982-1987

J.H.M. Karsten

Initial investigations were aimed at purifying charcoal samples of any minerals. These purified charcoal were successfully marked with potassium and calcium to serve as standards in further research.

Studies on the effect of take-off angle revealed that reliable determinations depended largely on the correct take-off angle. Existing analytical programmes were only applicable on samples with highly polished surfaces. Biological samples did not comply to these conditions and investigations were continued by comparing samples with suitable standards.

The background of spectra presented problems in identification and determination of intensities of peaks. Several methods of removing background were examined. A more serious problem was the overlapping of the K peak of potassium and the K peak of calcium. By generating theoretical peaks, manipulations of spectra were possible and these two peaks could be seperated successfully.

The poor reproducibility of the settings on the electron microscope had a detrimental effect on the final success of this facet. Metal markers were incorporated in samples in order to normalise sample counts in terms of marker counts. Constant normalised peak counts were obtained with this technique but the very poor reproducibility of the relevant settings were again emphasised.

PEARS

• *Crop science*

VV.2442/30/5/1: ROOTING OF BP PEAR ROOTSTOCKS. 1978-1987

P. van Huyssteen

Factors affecting rooting of BP pear clonal rootstocks with three different vegetative propagation techniques were investigated. Hardwood cuttings were used with the direct-planting and hotbin method while leafy (softwood) cuttings were used with the mistbed method.

Intra-plant factors like mother-plant age, shoot length, epicormic shoots, secondary growth and terminal shoot portions had a significant influence on rooting. Mother-plant manipulations (bending and pruning) which stimulate regrowth, also resulted in better rooting, but a lower survival rate was obtained. Time of cutting collection had a significant influence on rooting. The optimum collection time for hardwood cuttings was established at the end of autumn (May), whereas for leafy cuttings mid-summer (January) was the optimum collection time.

Different root promoting treatments resulted in better rooting. Basal wounding of hardwood and leafy cuttings resulted in a significant better rooting percentage. Indolyl butryic acid (IBA) applied a high concentration (5 000 mg/ℓ) according to the quick-dip method increased rooting percentage significantly. An IBA salt solution prepared with potassium hydroxide and water gave better results than the standard IBA-ethanol solution. A cold treatment (4 to 6 weeks at 4,5 °C) improved the rooting of hardwood cuttings with the hotbin method significantly. Carbohydrate studies on the cold-stored cuttings could, however, not explain the effect of the cold treatment. Rooting co-factor studies on cold-stored cuttings, however, showed an increase in rooting promotors and a decrease in rooting inhibitors, which is a possible explanation for the better rooting percentage of cold-stored cuttings.

Finnish peat moss as a rooting medium produced better results than Irish peat moss and other cheaper rooting media.

Three vegetative methods to propagate the BP rootstocks successfully have been established, and nurserymen already applied the results of this facet. This facet is therefore terminated.

PEACHES

• *Pests*

VV.2443/20/1/1: BIONOMICS OF FALSE CODLING AND CODLING MOTH ON PEACHES. 1982-1985

T.L. Blomefield

False codling moth (FCM) *Cryptophlebia leucotreta* (Meyr.) and codling moth (CM), *Cydia pomonella* (L.) are important pests of deciduous fruit. FCM is confined mainly to peaches and plums. CM is a key pest on apple and pears and can be of importance in apricots. CM has also been reported to infest peaches and plums.

Before this study the proportion of infestation of peaches and plums owing to FCM and CM was unknown. This is because the larvae of these two pests are similar in appearance preventing positive identification in the field. The economic importance of these pests was determined for 5 peach, 3 nectarine and 2 plum cultivars, based on per cent infestation in unsprayed trees in the Ashton and Groot-Drakenstein areas.

The peach cultivars were Malherbe, Woltemade, Florabella, Fullard Keimoes and Fairtime. Nectarine cultivars were Independence, Autumn Grand and September Grand. The two plum cultivars were Santa Rosa and Songold. CM larvae were found in the fruit of only three cultivars, *viz* the peach Fairtime and the nectarines Autumn Grand and September Grand. Of the 706 larvae identified from the 5 peach and 3 nectarine cultivars only 1,7 % were CM larvae. No CM larvae were found in the fruit of the two plum cultivars. FCM infestation in peach, nectarine and plum cultivars ranged from 0,7 % to 43,9 %; 0,6 % to 7,6 % and 0,9 % to 6,7 %, respectively. Sample sizes ranged from 905 to 4 999 fruit. FCM infestation was greatest in the Ashton area.

The study has shown that FCM is of economic importance in peaches, nectarines and plums; CM being of no consequence on these fruits. This is verified by the high number of FCM larvae and either the absence or few CM larvae recorded in all sampled fruit.

PEACHES

• *Crop science*

VV.2443/30/3/2: OPTIMUM PLANTING DISTANCES AND CULTURAL PRACTICES FOR PEACHES IN HIGH DENSITY PLANTINGS IN THE SUMMER RAINFALL AREA. 1978-1987

R.A.W. Gardner

Three planting densities namely 5 m x 1,5 m, 5 m x 2 m and 5 m x 3 m were compared for Rhodes, a

mid-season peach cultivar. The different planting distances did not have a significant effect on total yield but fruit size was affected adversely by the denser spacing. It was shown that the vase shape was unsuitable for a spacing of 5 m x 1,5 m. The lower sections of trees were shaded severely which caused poor fruit size. Limiting the height of trees to be manually thinned and picked from the ground and also to reduce shading, by means of summer and winter pruning, reduced crop levels and impaired fruit quality.

PEACHES

• *Technology*

VV.2443/52/2/2: COMPARISON OF METHODS OF MATURITY DETERMINATION OF CANNING PEACHES. 1984-1986

B.K. Nortjé

Light reflection from the surfaces of whole peaches of different maturities were measured at two wavelength regions by using filters. The maturity of the halves was judged by a panel after canning. Reflection readings (difference between values obtained with the two filters) were compared with the maturity scores of the panel.

Comparable coefficients of determination were obtained with both types of photocells tested. Varying of the voltage of the light source to obtain constant total reflectance resulted in higher values, 0,851 being the lowest. The regression lines obtained from transformed values of fruit of different size groups had significant differences in respect of Y intercepts and slopes. In the case of peaches for canning the stage when the fruit becomes acceptable for canning is important. At this stage (when a maturity score of about 7 is reached on a 0-10 point scale) size is not very important.

PLUMS

• *Pathology*

VV.2444/19/1/3: IDENTIFICATION OF THE *MONILINIA* SPP. INVOLVED IN THE BLOSSOM BLIGHT/BROWN ROT DISEASE COMPLEX ON PLUMS. 1982-1987

Helen E. Schlagbauer

Monilinia isolates recovered from different stone fruit producing areas in the South-western and Southern Cape Province and the Little Karoo were compared with reference cultures of different *Monilinia* spp. Taxonomic criteria included cultural characteristics on potato-dextrose agar, interactions on oatmeal agar, extent of spore production and germ tube characteristics. All local isolates were assigned to *M. laxa.*

Historically, most of South Africa's stone fruit propagation material has come from Europe. *M. laxa* is regarded as an Old World species. It is therefore not unexpected that *M. laxa* is the only *Monilinia* spp. occurring in the principal stone fruit producing areas of this country.

In other countries blossom and spur blight are the principal features and the most destructive phases of the *M. laxa* disease syndrome. As it is now clear that only *M. laxa* is responsible for these diseases in the winter rainfall stone fruit producing areas of South Africa, a re-evaluation of practices used to reduce fungal unoculum seems appropriate.

With *M. fructicola* ascospores are considered as an important part of the primary inoculum. However, *M. laxa* rarely forms apothecia. Control measures should therefore concentrate on primary inoculum produced from mycelium in previously infected parts.

PLUMS

• *Pathology*

VV.2444/19/2/1: INFECTION AND RELEASE OF *XANTHOMONAS CAMPESTRIS* PV. *PRUNI* IN PLUM TREES. 1979-1987

H.J. du Plessis

The possibility was investigated that the bacterial spot pathogen, *Xanthomonas campestris* pv. *pruni*,

invades Golden King plum shoots systemically through petioles of infected leaves. Masses of *X. campestris* pv. *pruni* cells were detected by scanning electron microscopy in xylem vessels in petioles of naturally infected and inoculated leaves. Colonies of the pathogen were also observed in cortex tissue of small shields of shoots, adjacent to infected leaves. High numbers of a rifampicin-resistant strain of *X. campestris* pv. *pruni* were recovered 4 and 8 weeks after inoculation from sections of uninoculated and symptomless veins, petioles and shoot tissues. Symptoms of bacterial spot developed within 8 weeks on main and secondary veins of uninoculated leaves located as far as 13 cm from the inoculated leaf on the same shoot. Weekly isolation indicated the constant presence of *X. campestris* pv. *pruni* in symptomless shields of shoot tissues obtained from a naturally infected Golden King orchard. The pathogen evidently entered shoots through veins of infected leaves and migrated systemically through shoots to leaves.

Summer canker symptoms of bacterial spot only developed if the pathogen was introduced into petioles or main veins within 4-5 weeks after shoot emergence. Inoculations by spraying the bacterial suspension into intercellular spaces on unwounded leaf surfaces, resulted in spring canker development at adjacent nodes during bud break. Both types of cankers were apparently associated with systemic spread of the pathogen from infected leaf and shoot tissues.

PLUMS

• *Pathology*

VV.2444/19/2/3: COMPARISON OF PHYTOPATHOLOGICAL, BIOCHEMICAL AND PROTEIN ELECTROPHORETIC CHARACTERISTICS OF *PSEUDOMONAS* STRAINS ISOLATED FROM PLUM TREES. 1984-1987

I.M.M. Roos

Eighty South African strains of *Pseudomonas syringae* and 33 reference strains were subjected to numerical phenetic analysis using 215 unit characters. Data were analysed using unweighted pair-grouping clustering on the simple matching (S_{sm}) coefficient. Three phenons were distinguished at S_{sm} 75,8 %. Most South African strains were assigned to one of two major phenons: *P. syringae* pv. *syringae* (phenon 1) and race 1 of *P. syringae* pv. *morsprunorum* (phenon 2). Four *P. syringae* pv. *savastanoi* strains formed a tight sub-group within phenon 2, two local race 2 strains, and a *P. syringae* pv. *papulans* strain. Pathogenicity tests with five selected strains on apple, pear, plum and cherry trees confirmed the clear distinction between the two pathovars and between races 1 and 2 of *P. syringae* pv. *morsprunorum*. No significant differences in pathogenicity were detected when comparing *P. syringae* pv. *syringae* strains originally isolated from weed, pear or nectarine trees.

Viticulture

WINE GRAPES

• *Pathology*

WW.2462/19/2/4: EVALUATION OF ROOTSTOCK RESISTANCE TO CROWN GALL. 1981-1986

J.H.S. Ferreira

A field trial consisting of fourty grapevine rootstock cultivars and crosses, as well as Muscat d'Alexandrie, was conducted in the Upington district. All rootstock cultivars and crosses were artificially inoculated with five strains of *Agrobacterium tumefaciens* biotype 3 and evaluated for resistance over a two-year period. Paulsen 775 proved to be resistant to all strains whereas Kober 125 AA, Freedom, 3309 C, Harmony, Solonis, 101-14 Mgt., Paulsen 1045, Berlandieri 13/5 and Kober 5 BB appeared to be relatively tolerant. Jacquez, US 2-1, US 24-23, Muscat d'Alexandrie and US 24-10 were the most susceptible.

Host range differences occurred among the five strains of *A. tumefaciens* on the different rootstock cultivars. Five different host range patterns were evident. *Agrobacterium tumefaciens* biotype 3 strains 1771 and 2164 were the most pathogenic of the strains used.

• *Crop science*

WW.2462/30/2/3: OPTIMAL BUDLOAD FOR WINE GRAPES ON DIFFERENT ROOTSTOCKS AT ROBERTSON: MUSCADEL. 1980-1986

G.W. Fouché

The aim of this study was to determine the long-term effect of different budloads on the viticultural and oenological performance of Muscadel on different rootstocks.

Budload as well as rootstock cultivar had significant effects on yield and shoot growth obtained in this trial. For all rootstock cultivars an increase in budload increased the yield and decreased the shoot growth Different rootstocks differed concerning their reaction to different budloads. Under the conditions of this experiment 110 Richter, Ramsey and 101-14 Mgt. gave the best results concerning growth and production whereas symptoms of overcropping became evident with the other rootstocks especially when a budload o 40 buds per vine was used.

Generally a decrease in bunch and berry mass occurred when the budload was increased, while buddin percentage and fertility also decreased. These factors were sufficient to explain the production and shoo growth effects of different budloads on different rootstocks. Evidently the weaker the inherent vigour of rootstock, the more pronounced the deterimental effect of increased budloads became, mainly because of th negative effect of high budloads on the ratio of leaf surface area to unit mass of grapes. Differences in thi ratio, as induced by different budloads, were mainly responsible for differences in the chemical compositio of the grapes. It is clear that the turning point in wine quality is at different budloads for different rootstock and under the conditions of this trial 110 Richter performed better than the other rootstocks and if thi rootstock is used a budload of 32 buds per vine is recommended.

WINE GRAPES

• *Crop science*

WW.2462/30/5/2: RELATIVE PERFORMANCE OF CULTIVARS OF WINE GRAPES IN CLIMATIC REGION II: DARLING. 1975-1986

F. Baard

The aim of this study was to evaluate red wine cultivars for their adaptability to prevailing climat conditions and existing cultivation practices, so that recommendations can be made to producers in this regio

Eleven red wine cultivars were evaluated in this region, observations were made of yield, vigou phynologic data and wine quality over a seven-year period. Wine were made in the VORI's experimental cella

Tinta Barocca is recommended as an early to mid-season cultivar together with Pinotage (early seaso and Cinsaut (mid-season). Carignan, Cabernet Sauvignon ex Davis and Zinfandel can be considered cultivars that can be harvested after Cinsaut. **Cabernet Sauvignon (S.A.) and Sämling 3130 cannot be recommend** because of low yields.

Oenology

WINE

• *Technology*

WW.2471/52/1/3: WOOD AGEING OF WINES: WHITE WINES. 1981-1985

G.W.W. Wagener

Nature and scope

In order to ascertain which white wine cultivars are suited for wood maturation, preliminary tests were

carried out with St. Emillion, Semillon, Steen, Sauvignon blanc, S.A. Riesling and Chardonnay. Results showed that all wines made from above-mentioned cultivars could be matured in wood without decrease of wine quality. To follow up this work on wood maturation in more detail, it was decided to use only one cultivar, *viz* Semillon, a cultivar used extensively in France for this purpose.

The Semillon wines were made with and without skin contact and matured in Nevére Oak barrels of 150 liter capacity for 4, 8 and 12 months. These wines were bottled and stored for 3, 6 and 9 months at temperatures of 0 °, 18 ° and 25 °C after wood maturation.

Sensory evaluation of wine quality, cultivar and maturation character was done after each bottle-storage period by a panel of 17 judges. The results were statistically evaluated against the parameters, wood maturation time, vinification (skin contact, free-run) and bottle storage time and temperature.

After a 3-month bottle storage period, the wines were extracted with Freon II and the extracts analysed for esters and higher alcohols by gaschromatography.

Results

Increases in bottle storage temperature caused significant increases in the concentration of diethyl succinate and octanoic acid and decreases in i-amyl acetate and ethyl caprate. Skin contact wines showed significantly higher concentrations of ethyl acetate and diethyl succinate and significantly lower concentrations of i-butanol and hexanol than free-run wines, irrespective of wood maturation time.

However, sensory evaluation showed that wines of significantly higher overall quality were made from free-run juice, with 4 months wood maturation and 9 months bottle maturation time, irrespective of bottle storage temperature.

However, the effect of bottle storage temperature on the style of wine can be utilised in practice to introduce more or less of the wood maturation character and cultivar character in the final product.

BRANDY

• *Chemistry*

WW.2472/53/1/1: THE EFFECT OF SPECIFIC WINE COMPONENTS ON QUALITY OF BRANDY. 1979-1985
G.W.W. Wagener

Nature and scope

Nineteen commercially produced rebate wines with specific flavour components were obtained from various co-operative cellars over two consecutive seasons and distilled into brandy, by the Charante method.

In addition five experimental wines, with increasing concentrations of total polyphenols, made from Chenin blanc grapes, were similarly distilled. Most of the distillates were matured over a period of three years in French Limousin oak barrels of 160 ℓ capacity previously used to mature brandy for one year. The wine and brandy distillates were analysed for macro-components. The brandy distillates were evaluated over a period of three years by a panel of 10 experienced judges by means of a special score card indicating colour, nose and taste as well as the total points scored for each brandy.

Results

The total aldehydes in wines increased as the total polyphenol concentrations of the musts were increased.

The brandy distilled from these wines showed a steady increase in total higher alcohols as the total polyphenols increased. Although not statistically proven, through lack of replications, there seems to be a correlation between the total higher alcohols in the distillates and the total polyphenols of the wines, when the latter were present in concentrations of 296 mg/ℓ and higher.

These wines (total polyphenol of 296 mg/ℓ and higher), produced distillates which were termed as sharp and harsh. Maturing these distillates for as long as 3 years in limousin oak barrels, did not improve quality.

Most off-flavoured wines produced distillates of acceptable quality before and after wood maturation (3 years) and were of similar quality to distillates obtained from wines of desirable quality standards. However, certain specific off-flavours had a marked and lasting effect on the quality of the distillate. Rancidity in some wines produced a rancid flavour in the distillate, whereas the same off-flavour in other wines did not produce rancid distillates. Some rancid wines could thus be used for brandy distillation whereas other were not suitable. Identification of the specific aroma compounds causing the persistent rancid aroma would therefore provide a way of identifying such wines before brandy distillation. No such substances have as yet been identified. Other off-flavoured wines with wet-feather and yeasty-organic-insipid characteristics, also produce harsh and unclean brandy distillates not suited for brandy production.

It was not possible to correlate macro-components to brandy quality. However, a tendency of low total higher alcohol concentrations in distillates with high quality ratings (67 to 70 %) and high total higher alcohol concentrations in distillates with low quality ratings (34 to 38 %), was noted. Distillates with the highest quality rating (67 to 70 %) also had the lowest total aldehyde concentration.

Citrus and subtropical crops

CITRUS

- *Pathology*

SS.2481/19/1/3: ISOLATION OF THE GREENING ORGANISM OF CITRUS. 1971-1986
B.Q. Manicom

In the early 1970's it was generally believed that the causal agent of greening disease (GO) of citrus was a mycoplasma and attempts to culture it were begun on this basis.

In 1972 Dr J.N. Moll, using electron microscopy of the host and vector showed that the GO was in fact a bacterium of a gram-negative nature which gave hope that it could be cultured. This has not proven to be the case.

Over the next 10 years a group of bacteria known as the fastidious xylem or phloem limited bacteria were discovered as agents of a variety of plant diseases and many, although not all of these, have eventually been isolated in pure culture. As each new medium was invented, they or derivatives thereof were tested against the GO without success.

A number of physical purification methods were also tried but the titre of the organism in the source material was so low that few organisms could be obtained which were insufficient for further manipulation.

More recently it has been reported that the GO has been isolated, but this and other laboratories have been unable to duplicate the work, nor has pathogenicity been shown and thus there still remains some doubt as to whether the correct organism has been isolated. Antisera generated against this isolate in this laboratory did not react positively with diseased tissue.

In Taiwan monoclonal antibodies have been made to diseased tissue and some of these appear to be specific towards the GO which will help deciding whether the isolated organism is in fact the GO.

CITRUS

- *Crop science*

SS.2481/30/1/3: CITRUS AND RELATED GENERA AS ROOTSTOCKS FOR CITRUS. 1970-1985
J.H. de Lange

Twenty species of the orange subfamily Aurantioideae (family Rutaceae) as well as a number of hybrids were evaluated as potential rootstocks for citrus.

Candidate rootstocks were assessed under field conditions in terms of bud-union compatibility, tree vigour and fruit yield over a period of four years. To date these preliminary assessments have indicated that a *Microcitrus*-sweet orange hybrid [*Microcitrus* sp. x (*Citrus sinensis* 'Shamouti' x *C. sinensis* 'Mediterranean Sweet')] shows promise as a dwarfing rootstock for Olinda Valencia [*C. sinensis* (L.) Osbeck] and Marsh

grapefruit (*C. paradisi* Macf.) scions. Eureka lemon [*C. limon* (L.) Burm. f.] shows vigorous tree growth on the *Microcitrus*-sweet orange hybrid as rootstock.

Flying Dragon trifoliate (*Poncirus trifoliata* var. *monstrosa* (T.Ito) Swing.) exhibited dwarfing characteristics with Olinda Valencia and Marsh grapefruit. Two apparent drawbacks of Flying Dragon as a dwarfing rootstock that were observed over the four-year trial period, were slow tree growth and very poor fruit yield.

The initial results as to the performance of *Severinia buxifolia anisata* (Willd.) Hook. f. ex Benth., as candidate rootstocks for Eureka lemon justify further investigation. The results on tissue compatibility of *Clausena anisata* with *Citrus* species have been reported in 1971 by J.H. de Lange and A.P. Vincent who published the results in the Citrus and Subtropical Fruit Journal, July 1971.

CITRUS

• *Crop science*

SS.2481/30/2/3: EVALUATION OF FIVE NAVEL SELECTIONS. 1978-1984
J.G.J. Maritz

The aim of this investigation was to evaluate five promising navel selections in order to find the most suitable selection for commercial plantings. Fruit yield, fruit size and internal quality of the following selections were compared for seven seasons: Palmer, Markuskraal, Bahianinha, Addo and Buffelspoort navel.

At the Sundays River Research Station near Addo, a cool citrus producing area, the best yield was obtained from Bahianinha navel. Bahianinha produced an average yield of 120 kg/tree/annum whereas Palmer and Markuskraal produced 77 kg and 75 kg/tree/annum, respectively. Buffelspoort and Addo navels produced 49 and 39 kg/tree/annum, respectively. All the selections produced fruit of good internal quality. For commercial plantings it seems feasable to plant Bahianinha navels in the Sundays River Valley.

CITRUS

• *Crop science*

SS.2481/30/2/7: CITRUS CULTIVARS AND SELECTIONS - MID - SEASONS. 1976-1984
C.F. Human

The aim of this investigation was to evaluate five promising mid-season selections and MidKnight, a Valencia, in three climatic regions in order to find a selection better or equivalent to Tomango.

The five selections used were as follows:

1. Tomango
2. Shamouti
3. Clanor
4. MidKnight (only at Addo and Citrusdal)
5. Nucellar Gem (only at Addo and Citrusdal)
6. Letsitele (only at Letsitele)

Fruit yield, fruit size and internal quality was compared for three seasons at Citrusdal and the Sundays River Research Station near Addo, and for two seasons at Letsitele.

At Addo and Citrusdal the best yield was obtained by MidKnight. A good internal fruit quality was obtained by all the selections. Of the mid-seasons, the best yield came from Nucellar Gem and Tomango. At Letsitele, Shamouti did well and had a good fruit size. Small fruit were obtained from Nucellar Gem. All the selections had the trend of alternative bearing resulting in smaller fruit during the productive years. The best internal fruit quality was obtained by Nucellar Gem with Tomango second.

PINEAPPLE

• *Chemistry*

SS.2482/53/1/1: NITRATE CONTENT OF PINEAPPLE FRUIT FOR CANNING PURPOSES. 1978-1985

B.L. Smith

Detinning of tins used for canning of pineapple fruit became a serious problem in the Eastern Cape area. As this was shown to be caused by high nitrate concentrations in the fruit, an extensive investigation was undertaken to determine which farming practices were involved in nitrate accumulation in pineapple fruit.

Excessive application of nitrogen to pineapple lands was shown to be one of the main factors responsible for high nitrate concentration in the fruit. Nitrate accumulates mainly in the lower part of the fruit (styler end) but also to a certain extent in the upper part (top end) and very little in the main edible parts or skin. Because of a very close correlation between nitrate concentration in the different parts of the fruit, only one part needed to be analysed for assessing the nitrate status of the fruit and not the whole fruit. The highest nitrate concentrations in the fruit (up to 116 mg/kg in the juice) was found in fruit harvested in August from lands with a southern aspect. Pre-plant soil fumigation and application of potassium fertilisers both decreased the nitrate concentration of the fruit.

Climatic factors, especially a dry spell before harvest and/or reduced light intensity, were shown to cause considerable accumulation of nitrate in the fruit.

AVOCADO

• *Physiology*

SS.2483/03/1/6: AVOCADO PHYSIOLOGY WITH SPECIAL EMPHASIS ON WATER RELATIONS. 1981-1986

J.P. Bower

The effect of long-term irrigation on water relations of 'Fuerte' avocado trees, and the consequences for fruit ripening and physiology, particularly physiological disorders, were studied.

Four irrigation regimes were used, namely dryland relying on rainfall, occasional (irrigation when soil moisture tension reached 80 kPa), regular (soil moisture tension 55 kPa) and frequent (soil moisture 35 kPa).

Seasonal tree leaf water potential was studied. This became more negative during the dry season (winter and spring) and less negative during the period of summer rainfall. During the dry periods, the dryland and 80 kPa treatments had considerably more negative leaf water potential than the 55 kPa and 35 kPa regimes. These differences decreased during the summer rainfall period.

Acclimation was studied by measuring leaf osmotic pressure and osmotic pressure at zero turgor. A pattern similar to seasonal leaf water potential emerged. Further, the dryland treatment showed higher osmotic pressure, particularly at zero turgor, during winter and spring. It was concluded that these trees may have acclimated. Diurnal cycles of stomatal resistance, transpiration and leaf water potential on a summer, two winter and a spring day were monitored. Dryland trees showed acclimation, with delayed reaction to environmental water demand and decreasing soil moisture. Trees of the 80 kPa treatment showed greatest stress.

Fruit water potential became more negative between April and July, with fruit softening becoming more rapid. Treatment differences were inconclusive.

Polyphenol oxidase activity (PPO), soluble and total, was measured. For fruit picked in April and July 1983, the 55 kPa treatment showed the lowest activity and the 80 kPa the highest. Storage at 5,5 °C for 30 days increased the activity, whereas fruit softening decreased it. July activity was higher than the April-harvested fruit. The same pattern emerged for fruit harvested in April 1985, although treatment differences were not significant. Rainfall was considerably higher during the fruit development period of 1985 fruit as compared with that of 1983. A significant interaction between restricted container ventilation during ripening and irrigation history was obtained, the 80 kPa fruit showing higher PPO activity than 55 kPa fruit.

Ethylene evolution during ripening showed a normal climacteric pattern for 55 kPa and dryland fruit, but a delayed peak for 80 kPa fruit.

Fruit calcium concentrations showed rapid changes between 7 and 16 weeks after fruit set thereafter remaining constant to harvest. There were no clear treatment differences.

Fruit abscisic acid levels at 50 % soft (100 % is eating soft) were lowest in 55 kPa fruit, and highest in 80 kPa. A significant correlation between these values and soft fruit PPO activity was found.

A preliminary fruit quality prediction model is suggested.

AVOCADO

- *Physiology*

SS.2583/03/2/1: DEVELOPMENT OF TISSUE CULTURE TECHNIQUES FOR THE PRODUCTION OF EMBRYONIC CALLUS AND PROTOPLASTS IN AVOCADOS. 1984-1986

Pauline A. Harty

Callus cultures of Duke 7 obtained from Prof. R.A. Dixon, Royal Holloway College (University of London) in 1981 were being maintained on the medium of Dixon and Fuller (1976). It was originally intended that experimentation be carried out using this callus. The results of a trial carried out to determine the auxin/cytokinin dependence of this callus line, indicated that it had become habituated. New Duke 7, Fuerte, Edranol and *Persea indica* callus cultures were therefore induced for use in further experimentation. Various experiments were carried out to induce embryogenesis in these callus lines, however, none of the treatments was successful in this aim.

It was therefore decided that callus induced from immature embryos may have greater potential for embryogenesis. Callus was therefore induced from immature embryos of Duke 7 and Fuerte. The ontogeny of embryogenesis was followed in this callus.

Once it had been established that embryogenesis did indeed occur within callus lines induced from immature embryos of Duke 7 and Fuerte, the final aim of this facet was to obtain an experimental system for the isolation and culture of protoplasts from these callus lines. This was achieved through enzymatic isolation of the protoplasts from actively growing callus cultures. What remains to be achieved is the induction of embryogenic callus from isolated protoplasts.

AVOCADO

- *Physiology*

SS.2483/03/2/3: ESTABLISHMENT AND MULTIPLICATION OF ROOTED AVOCADO PLANTLETS IN CULTURE. 1984-1986

Pauline A. Harty

The first aim of this facet was the establishment of pathogen-free cultures. This was achieved through surface sterilisation of the explant material in 3,5 % commercially available sodium hypochlorite solution for 1-3 min.

The second aim was concerned with explant growth and multiplication *in vitro*. Shoot growth and multiplication was achieved, however, all attempts to obtain rooting of explants *in vitro* failed. It is believed that until a greater understanding of the juvenility factor is achieved, it will be fruitless to pursue this facet any further at this stage.

OTHER SUBTROPICAL CROPS

- *Physiology*

SS.2486/03/1/1: OTHER SUBTROPICAL CROPS: MERISTEM CULTURE OF GINGER. 1985-1986

J.H. de Lange, P. Willers and Magda Nel

The root-knot nematode species *Meloidogyne incognita* and *M. javanica* pose a serious threat to

cultivation of ginger in South Africa. Dipping of planting material (rhizomes) in systemic nematocides does not result in adequate control of nematodes which are also found in the medulla tissue of rhizomes with the result that yields are drastically suppressed and shelf life or rhizomes are reduced.

Tissue culture was investigated as a method of obtaining propagation material free from nematodes. *In vitro* culture of shoot tips from emerging buds on stored rhizomes which were heavily infested with root-knot nematodes, resulted in a plant completely free from nematodes.

PLANT PROTECTION RESEARCH

Entomology/Zoology

INSECTS

• *Integrated control*

PB.2511/23/1/1: LABORATORY EVALUATION OF CANDIDATE PESTICIDES AGAINST *HELIOTHIS ARMIGER*. 1978-1986

N.C.J. Basson, S.J. van der Walt and J.D. Möhr

Laboratory evaluations of the effect of insecticide on *Heliothis armiger* were an adjunct to field trials for the development of a spray programme. They were undertaken for preliminary screening prior to more comprehensive testing in the field and to supplement the investigation of resistance to insecticides in populations of the pest which is described in a companion report. The procedure followed was to expose *H. armiger* larvae from a laboratory culture to dilution ranges of insecticides and to determine the mortality rates. Both ground and aerial spraying was simulated.

The insecticides submitted for testing were coded but contributed to the eventual registrations listed by Bot *et al.* (1986). Nevertheless, two important characteristics of the synthetic pyrethroids were evident. Firstly, this group of insecticides are extremely effective against *H. armiger* larvae, as is reflected in their widespread use. Secondly, their ovicidal properties against *H. armiger* were found to be limited. This is not a shortcoming as far as cotton production is concerned since the integrated pest management systems which are currently in use rely on larval counts, with egg counts merely an indication of potential larval populations.

Laboratory trials suggested that it may be feasible to lower the concentrations which are applied to cotton. However, the results were inconclusive due to the restrictions which are inherent to laboratory evaluations and will need to be verified in the field. Provision is made in other registered facets to pursue this aspect which has important implications for pest management.

Reference

BOT, J., SWEET, S. & NORA HOLLINGS, 1986. *A guide to the use of pesticides and fungicides in the Republic of South Africa.* 31st Edition. Department of Agriculture and Water Supply.

INSECTS

• *Integrated control*

PB.2511/23/1/3: INVESTIGATION OF RESISTANCE TO INSECTICIDES IN *HELIOTHIS ARMIGER* IN SOUTH AFRICA. 1978-1986

N.C.J. Basson, and J.D. Möhr

Studies were undertaken to examine field populations of *Heliothis armiger* (Hübner) for resistance to insecticides. Initially Endosulfan, which was in general use against *H. armiger* during the 1970's, was tested, followed by limited testing of the synthetic pyrethroid Cypermethrin. The procedure followed was to collect larvae in the field from several cotton growing areas (mainly in the Eastern Transvaal), multiply them in

laboratory cultures and then expose the larval progeny to different concentrations of insecticides in the laboratory. The results were compared to those found for a non-resistant laboratory culture of *H. armiger*.

Indications of a mild resistance to Endosulfan were found, but were inconclusive. Tests of Cypermethrin from one locality showed no sign of resistance. It is concluded that while resistance of *H. armiger* to insecticides applied to cotton is not evident in South Africa at present, it should nevertheless be guarded against. For example, it is generally accepted that synthetic pyrethroids should be avoided during the first 12 weeks after plant emergence and that insecticides are used with caution at all times; this is particularly relevant to cotton production in South Africa, where an integrated pest management system is in operation.

H. armiger occurs on a wide range of crops, rendering this pest particularly vulnerable to the development of resistance to insecticides, and it is recommended that similar restrictions should be more generally applied to allow for a period each year during which synthetic pyrethroids are withheld altogether. Furthermore, the resistance levels should be continuously monitored, preferably in the field, and the efforts of the Department should be co-ordinated with those of the private sector.

INSECTS

• *Integrated control*

PB.2511/23/1/7: THE INFLUENCE OF RAIN AND OVERHEAD IRRIGATION ON THE SURVIVAL OF *HELIOTHIS ARMIGER* ON COTTON. 1985-1986

N.C.J. Basson, and J.D. Möhr

The influence of rain and overhead irrigation on populations of *Heliothis armiger* eggs on cotton was studied in the laboratory with the aid of an irrigation simulator and in the field of comparing the wash-off of the eggs caused by a rainfall simulator and the overhead irrigation systems which are in general use in cotton production. The possibility of adapting irrigation practices to reduce populations of *H. armiger* to economically acceptable levels was evaluated.

H. armiger eggs are well adapted to avoid drowning when they are temporarily submerged under water droplets during irrigation. This is achieved by a well-developed respiratory system which relies on about 25 aeropyles to absorb air which is then trapped in inner chorionic layers.

Furthermore, the eggs are not damaged by the impact of water droplets. The water does, however, wash the eggs from the plants, the central theme of the study. Variations in droplet sizes (a convenient quantitative measure of the kinetic energy of the droplets) had no significant effect on the wash-off of the eggs. Therefore, the nozzles fitted to irrigation systems cannot be modified to improve wash-off. Increases in the impact angles with which droplets strike oviposition substrates improved the wash-off obtained in laboratory trials. Under field conditions the impact angles depend not only upon the trajectory of droplets, but also upon many other factors such as the tilting of leaves and wind. Such factors cannot be manipulated and were not pursued. Increases in the precipitation applied through irrigation (but not the duration of the irrigation period) was the only physical feature found to significantly improve the wash-off of *H. armiger* eggs. This hardly lends itself to manipulation since the amount of water applied is dictated by the requirements of the plants and the logistics of irrigation practices.

A number of features of *H. armiger*, including moth age, numbers of eggs laid per moth per night and the age of the eggs were found to have little or no effect on the numbers of eggs washed off. These aspects were not studied for their own sake, but to develop suitable techniques for assessing the adhesion and wash-off of the eggs; over a wider range of the variables they may well be significant. For the same reason many other factors of academic interest which may affect wash-off were ignored. Reductions in the proportions of viable eggs significantly improved the wash-off of the eggs, another feature which cannot conceivably be manipulated and which falls into the category of other mortality discussed below.

The characteristics of cotton plants influence both the selection of oviposition sites by *H. armiger* moths and the adhesion of the eggs, leaves were clearly preferred to other plant parts, but for evaluating the influence of irrigation whole plants were considered. The hairs on cotton leaves served to anchor *H. armiger* eggs whereas on other parts of the plants they tended to disturb the adhesion of the eggs; the nett result was that more *H. armiger* eggs were washed off from smooth (hairless) cotton varieties than from hairy ones. While this offers a tempting avenue for reducing the numbers of *H. armiger* in cotton, it is thwarted by the more important potential stimulation of jassid populations on smooth cotton varieties. Most of the eggs were laid in the upper third of the plants.

Somewhat unexpectedly, equal proportions of the *H. armiger* eggs were washed off by irrigation irrespective of the height in the plants at which they were laid. At face value about 30 % of *H. armiger* eggs were washed off by standard irrigation applications of about 50 mm. This is a gross overestimate for two important reasons. Firstly, the significance of mortality caused by irrigation reduces with increases in other mortality factors; egg parasitism, for example is considerable in *H. armiger* populations. Secondly, cotton fields are irrigated only every 10 to 12 days. The overall effect of irrigation was 4,5 % in a documented example. It is concluded that modifications to irrigation practices as a pest control strategy are not viable.

Nevertheless, individual irrigation applications can sometimes markedly reduce the numbers of *H. armiger* eggs in cotton fields. This is crucial for the timing of the surveys on which spray programmes are founded. The surveys should be conducted at least 4 days after irrigation. The direct benefits of eggs washed off will be exploited and perhaps more important, the eggs not washed off will have hatched. Thus the larval counts - on which spray programmes are based - will be a more reliable reflection of the status of *H. armiger* in cotton fields.

Plant pathology/Microbiology

FUNGI

• *Pathology*

PB.2521/19/1/3: CONTROL OF SEED-BORNE FUNGAL PATHOGENS BY INFUSION WITH CHEMICALS. 1982-1986

A.J.L. Phillips

The aim of this work was to determine the effect of fungicidal seed treatments on survival of seedlings grown from seed known to be infected with *Sclerotinia sclerotiorum*. The effectiveness of fungicides applied in acetone solutions was compared with conventional dry dressings.

In agar plate tests, *S. sclerotiorum* was completely eliminated by benomyl, procymidone, vinclozolin and iprodione applied either as dusts or in acetone solution. In glasshouse trials, the same fungicides were significantly more effective when applied in acetone suspensions than when applied in acetone suspensions than when applied as conventional dry dressings. None of the fungicides, applied by either method, had a deleterious effect on germination or vigour of disease-free seed. In the acetone application method 176 µg of benomyl infused into the testas of 1 g of seed compared with 2,0 mg used in conventional applications.

FUNGI

• *Pathology*

PB.2521/19/3/1: EPIDEMIOLOGY AND CONTROL OF DISEASES CAUSED BY THE FUNGUS *SCLEROTINIA SCLEROTIORUM*. 1982-1986

A.J.L. Phillips

This work was initiated to study the influence of meteorological factors on the epidemiology of the disease on sunflowers. Since germination of sclerotia to form apothecia (carpogenic germination) is a key process in the disease cycle, this was also studied. Fungicide spray programmes and applications of fungicides to soil were evaluated as possible methods of control. The possibility of using soil-solarisation for control of Sclerotinia diseases in horticultural crops was investigated. Sunflowers varieties were evaluated for resistance to Sclerotinia wilt.

Meteorological data from 5 sites over the period 1976-1986 was studied and correlated with previous outbreaks of the disease in these areas. "High risk"-areas and "high risk"-periods for Sclerotinia head rot of sunflowers were identified. The criteria used were: number of days in a month with maximum air temperature $< 22\,^{\circ}C$, rainfall of > 2 mm and < 3 hours sunshine. To take into account the occurrence of consecutive days with these conditions, monthly infection scores were formulated as follows: 1 day, score = 1; 2 days, score = 3; 3 days, score = 6; 4 or more days; score = 10. Such monthly infection scores

identified previous outbreaks of the disease in the major sunflower production areas of the Transvaal. If it is necessary for sunflowers to be grown in one of the high risk-areas it is recommended that the crop be planted late so that flowering coincides with low risk-periods in autumn.

A model that describes the process of carpogenic germination was formulated and used to develop a method for comparing germinability and predicting germination of sclerotia. By use of this model it was found that germinability increased with the age of the sclerotia and was enhanced by a period of exposure to soil. The optimum temperature for germination lies between 18-20 °C.

A fungicide spray programme is not economically feasible because of the problems involved in spraying the sunflower crop and the length of time for which it must be protected. Applications of vinclozolin or procymidone to soil significantly reduced the numbers of apothecia formed in a crop of sunflowers.

Sunflower varieties were evaluated for resistance to Sclerotinia wilt in 1983/84 and 1985/86. Although the varieties were planted in land heavily infested with sclerotia of the pathogen less than 1 % were infected and comparisons of resistance were impossible. It was concluded that wilt disease is of minor importance on sunflowers in South Africa.

Initial work on solarisation of soil infested with sclerotia yielded promising results. Sclerotia were largely eliminated from the top 5 cm of soil and their viability and germinability was markedly reduced at greater depths. This may be a useful control method in market gardens.

FUNGI

• *Pathology*

PB.2521/19/3/2: BEHAVIOUR AND SURVIVAL OF THE FUNGAL PATHOGEN *SCLEROTINIA SCLEROTIORUM* IN CULTIVATED SOILS. 1983-1986

A.J.L. Phillips

This work was initiated to determine the hyperparasites associated with sclerotia and how they affect natural populations of sclerotia in soil. The possibility of using hyperparasitic fungi to control Sclerotinia wilt of sunflowers was also studied.

Two hyperparasites were isolated, *viz Coniothyrium minitans* and *Gliocladium virens*. Other fungi were isolated but they were either non-parasitic or weak hyperparasites. There was no correlation between hyperparasites isolated and crop type. Sclerotia from irrigated lands were more heavily infested than sclerotia from dry land crops.

C. minitans and *G. virens* were found to be aggressive parasites that infected and decayed all sclerotia inoculated with them. Other fungi isolated from sclerotia had little effect on their viability. *G. virens* was active over the range of agricultural soil pH and over a wide range of soil moisture levels. The main factor restricting its activity in soil was its temperature requirements. Field trials to evaluate the efficacy of *G. virens* as a biocontrol agent for Sclerotinia wilt of sunflowers were inconclusive due to severe drought conditions.

BACTERIA

• *Nitrogen fixation*

PB.2522/09/1/10: DEVELOPMENT OF IMMUNOLOGICAL METHODS FOR QUALITY CONTROL OF LEGUME INOCULANTS CONTAINING BACTERIA. 1985-1986

H.H. Lochner

Before marketing, samples of each batch of legume inoculant manufactured in South Africa are tested by the Plant Protection Research Institute for *Rhizobium* numbers and strain identity by means of plate counts and a serological method. In an attempt to develop a cheaper and less cumbersome testing procedure the use of the indirect and double antibody sandwich (DAS) ELISA techniques, which would simultaneously determine the number and identity of rhizobia in peat inoculants, has been investigated.

Attempts were made to correlate readings obtained with the indirect and DAS ELISA methods with plate counts of each two *Rhizobium* and three *Bradyrhizobium* strains in peat inoculants. Plate counts and

DAS ELISA estimates of viable cell numbers of *B. japonicum* strain WB1 in soybean inoculants produced by two manufacturers over two seasons were then compared.

Indirect ELISA readings and plate counts of rhizobia in peat could not be correlated, as indirect ELISA results were inconsistent.

Attempts to use the DAS ELISA method to estimate numbers of the fast-growing *Rhizobium* strains in peat inoculants have not been successful. The DAS ELISA colour reactions were weak and a non-specific reaction with peat suspensions occurred.

In contrast, DAS ELISA colour gradients were obtained with high dilutions of inoculant suspensions of each of three slow-growing *Bradyrhizobium* strains studied, but inhibition of colour reactions occurred in the lowest dilutions. By allowing peat particles in the first dilution to settle for 3 h, the inhibition effect was marketly reduced. When DAS ELISA readings and plate counts of the strains in the inoculent were then correlated, a highly significant linear relationship was obtained between the $\log_{10}$ number of colony forming units g^{-1} peat and DAS ELISA absorbance values at 405 nm.

With the exception of inoculants produced by one of the manufacturers in the second season, DAS ELISA estimates of viable cell numbers in soybean inoculants produced from gamma-irradiated peat were in general agreement with viable cell counts. Viable cell numbers in inoculants produced from steam-sterilised peat, and from gamma-irradiated peat by one of the manufacturers in the second season were lower than cell numbers estimated by DAS ELISA. The necessity of confirming with viable cell counts in inoculant quality control tests was thus emphasised. *B. japonicum* strain WBI antigen has also been detected in sterilised soybean inoculant by DAS ELISA, which further complicated matters.

A single DAS ELISA test cannot safely replace the plate count and serological strain identification test as quality control test. If DAS ELISA and a viable cell count, e.g. the simple Miles and Misra drop plate count is combined, a suitable technique is available to determine *Bradyrhizobium* numbers and strain identity in legume inoculants. Because of some inconsistencies which still complicate interpretation of DAS ELISA and its complementary test, it is not recommended for use in the quality control system of legume inoculants.

PASTURE CROPS

• *Pathology*

PB.2526/19/1/4: OCCURRENCE AND DISTRIBUTION OF PASTURE CROP DISEASES IN THE WESTERN CAPE: *MEDICAGO* SPP. 1981-1987

S.C. Lamprecht

The occurrence and importance of fungal diseases of *Medicago* spp. in the Winter Rainfall Region of South Africa were studied. During the 1982 growing season, 42 different accessions of annual *Medicago* spp. (medics) in 12 areas of the South-western Cape were examined and sampled for foliage diseases. In 1984, a survey of fungi associated with root rots of medics in 13 districts in the South-western Cape was undertaken. A new fungal disease of *Medicago truncatula* was described and a stem nematode was recorded on *Medicago sativa* (lucerne) in South Africa for the first time since 1911.

Foliage diseases recorded on medics were as follows: Phoma leaf and stem spot (*Phoma medicaginis* var. *medicaginis*), Leptoshaerulina leaf and stem spot (*Leptosphaerulina briosinana*), anthracnose (*Colletotrichum trifolii* and *C. destructivum*), Stemphyllium leaf and stem spot (*Stemphyllium vesicarium*), Cercospora leaf and stem spot (*Cercospora medicaginis*), powdery mildew (*Erysiphe polygoni*), rust (*Uromyces striatus*) and common leaf spot (*Pseudopeziza medicaginis*). Phoma leaf and stem spot was the most common foliage disease.

Medic root rot occurred significantly more frequently in old than in newly established fields. The fungi most frequently isolated from root lesions were *Fusarium acuminatum, F. avenaceum, F. equiseti* and *F. oxysporum*. The five most pathogenic fungi were *F. avenaceum, F. culmorum, F. graminearum* Group 1, *Pythium irregulare* and *P. ultimum*. Medic root rot is an increasingly important factor in the decline of medic pastures in South Africa.

Cylindrocladium scoparium was isolated from diseased root and crown tissue of *M. truncatula* cv. Borung plants collected from a field plot at Porterville in the South-western Cape Province. The fungus caused post-emergence damping-off of seedlings, leaf and stem spot and root and crown rot of *M. truncatula* cv. Borung. This is the first report of a disease caused by *C. scoparium* on an annual *Medicago* spp.

Stem nematode (*Ditylenchus dipsaci*) was recovered from lucerne plants in the Oudtshoorn district,

Cape Province. The severely damaged plants showed a white discolouration of the stems and leaves, stunting and a distortion of stems and leaves. It is recommended that commercially available lucerne cultivars in South Africa be evaluated for resistance and that regulations to restrict the dissemination of the nematode in seed should be introduced.

PASTURE CROPS

• *Pathology*

PB.2526/19/1/6: PHYTOPHTHORA ROOT ROT OF THE PASTURE CROP LUCERNE. 1982-1987

A.H. Thompson

Eighteen out of 25 farms sampled showing root rot patches in the main lucerne production areas of the Transvaal and Cape Province had Phytophthora root rot (PRR) present. PRR in South Africa is unique, in that two species of *Phytophthora* can cause the disease, *viz P. megasperma* f.sp. *medicaginis* and *P. drechsleri* (elsewhere in the world, *P. megasperma* f.sp. *medicaginis* is the only reported pathogen of PRR). These are the first reports of *P. drechsleri* causing PRR of lucerne, as well as both species together causing the disease, and the first report of *P. megasperma* f.sp. *medicaginis* isolated from lucerne roots in South Africa.

In the Transvaal both species were pathogenic. *P. megasperma* f.sp. *medicaginis* was a more serious pathogen than *P. drechsleri*, with disease severity indices (DSI) of 1,6-(x=2,4)-3,1 and 1,2-(x=1,7)-2,2, respectively (using a 1-5 assessment scale).

In the Cape Province, only *P. megasperma* f.sp. *medicaginis* was considered pathogenic, with a DSI range of 1,0-(x=1,7)-3,2. *P. drechsleri* on the other hand was not pathogenic in greenhouse tests, having a DSI range of 1,0-(x=1,0)-1,1, even though it was consistantly isolated from diseased roots and baited soil. Both species occurred together in the same field on some farms in both the Transvaal and the Cape Province.

Seven isolates of *P. megasperma* f.sp. *medicaginis* and 16 isolates of *P. drechsleri* were identified and fully described. *P. megasperma* f.sp. *medicaginis* is considered the most important pathogen of PRR in the areas sampled, while *P. drechsleri* can be a problem in the hot, irrigated areas.

PASTURE CROPS

• *Pathology*

PB.2526/19/1/7: EVALUATION OF IMPORTED CULTIVARS OF THE PASTURE CROP LUCERNE FOR DISEASE RESISTANCE. 1982-1987

A.H. Thompson and S.C. Lamprecht

Seventeen field trials from 11 localities in the country were sampled between March 1983 and April 1985. Thirty to 36 imported lucerne cultivars were assessed for resistance to fungal leaf and stem pathogens. Cultivars were randomly arranged within four replicate blocks at each field trial. Nine sampling points were taken in each cultivar with all leaf and stem diseases assessed at each sampling point. Ten leaflets and 10 stem pieces were randomly selected and assessed for disease severity of individual leaf and stem pathogens.

The differences in resistance between cultivars for all leaf and stem diseases were small. UC 193, 77-79T4, PB 572 and WL 77-78 showed the highest resistance to leaf and stem diseases. These figures were the most accurate of the survey as 13 trials were sampled.

Seven leaf and stem pathogens were recorded, but only lepto leafspot (*Leptosphaerulina trifolii*) and rust (*Uromyces striatus*) occurred in enough trials to assess resitance. Cultivars showed a small range of resistance with rust with PB 572 showing the highest resistance. Resistance values for individual pathogens were less accurate as they were based on 7 trials only.

Owing to the low number of trials sampled, and the considerable variation in resistance between cultivar trials no accurate conclusions could be drawn. Problems that were experienced during the assessements are discussed.

A guide to identify the major diseases of lucerne in South Africa was brought out primarily for extension officers but also to help the more progressive lucerne farmer recognising lucerne diseases. Eleven diseases are dealt with, *viz* lepto leafspot, spring black stem and leafspot, rust, common leafspot, stemphylium leafspot, summer black stem end leafspot, downy mildew, anthracnose, phytopthora root rot, crown/root rot and bacterial wilt.

The guide is designed horizontally, with a colour photograph of disease symptoms on the left, a short description in the centre, and a distribution map on the right for each disease. The descriptions are short, with the major characters of each disease in bold type. It is hoped that this guide will help those people involved in the practical aspect of lucerne production in South Africa.

A disease resembling witches' broom was investigated on lucerne in North-western Transvaal, where yield losses of up to 50% were reported. Affected plants were stunted, had proliferating stems and had abnormally small leaves, and displayed phyllody, negative geotrophism and chlorosis. Pleomorphic bodies were present in phloem tissue only in affected roots and stems when viewed under the Transmission Electron Microscope. Bodies were spherical to filimentous, and were 60-650 nm in diameter. They occurred in sieve-elements, and were concentrated at sieve-plates. Affected tissue cut and stained with DAPI, and viewed under a fluorescence microscope also revealed large numbers of DNA-staining bodies in the phloem, but not in adjacent xylem, cambial or cortical tissues. Attempts to transmit the disease using mechanical methods and by dodder proved unsuccessful. It was concluded that the probable cause of witches' broom of lucerne in the Transvaal was a MLO (Mycoplasma-like organism).

ANIMAL PRODUCTION PROMOTION

ANIMAL PRODUCTION AND ANIMAL PRODUCTS RESEARCH

Animal production

DAIRY CATTLE

• *Nutrition*

VS.3112/05/1/6: GRAIN SORGHUM FOR LACTATING DAIRY CATTLE. 1985-1987
L. Möller

This experiment was conducted to determine to what extent grain sorghum could replace maize in a dairy cattle diet and to what degree it is acceptable to the dairy cow.

Six diets were fed with maize to grain sorghum ratios of 100:0; 80:20; 60:40; 40:60; 20:80 and 0:100. The grain sorghum was of a sweet variety and was milled through a 3 mm sieve.

Twelve lactating Friesland cows were used after peak production had been reached in an unbalanced change-over design. Each cow was subjected to four treatments, each which lasted six weeks of which two weeks were adaptation period. The concentrate was fed *ad libitum* with lucerne, as source of roughage, fed at 1,5 % of body mass. Water was freely available.

Concentrate intake, roughage intake, milk production, milk composition and nutrient digestibilities were determined. The digestibility coefficients were determined with three Friesland cows per treatment. The six diets were mixed with 40 % chopped lucerne to make up complete feeds.

It was found that there were no significant differences between treatments for milk production, concentrate intake, roughage intake, milk composition or the nutrient digestibilities.

Therefore, the conclusion can be made that grain sorghum can replace maize totally in a dairy cattle diet without any negative effects on milk production, milk composition or feed intake.

Animal products

MEAT

• *Norm studies*

VS.3121/50/1/10: INVESTIGATION INTO THE SHELF LIFE OF MEAT: THE INFLUENCE OF MICROBIOLOGICAL AND TECHNOLOGICAL FACTORS ON THE SHELF LIFE OF PREPACKAGED FRESH BEEF. 1981-1987
G.L. Nortjé

Monitoring the sanitary conditions in the South African fresh meat industry (supermarkets, abattoir and wholesaler), no consistency was found in the contamination of different cuts at different supermarkets, although there was a tendency of the forequarters to be more contaminated than hindquarters. Chiller surfaces, delivery truck surfaces and equipment had significantly different microbial loads at individual supermarkets. Although one supermarket group received carcasses with higher mean surface temperatures and microbial counts, a more efficient sanitary programme was in operation at supermarkets in this group. This resulted in consistent lower mean counts of different bacterial groups for all meat cuts included, hence a more stringent hygiene at retail level rendered meat with an extended shelf life. The total microbial count on meat cuts was followed by the psychrotrophs, the Pseudomonadaceae, the Enterobacteriaceae and the lactobacilli. Minced meat generally had the highest mean aerobic total microbial populations and might be a suitable indicator for monitoring the overall sanitary condition of a retail premises. Consequently, the sanitation level of retail premises is not a function of the microbial quality of carcasses received by such

supermarkets. Personnel surfaces (hands and clothes) and equipment like saws and mincers were consistent contributors to contamination of the final product at the retail level, while good refrigeration regimes enhanced meat quality, but dit not serve as a guarantee for quality.

From counts observed at 25 °C and 30 °C, the latter temperature yielded a higher count. The accuracy of predicting the psychrotrophic population by means of a 25 °C count depended on the habitat and environmental conditions. To predict the spoilage population, a count at 25 °C for 2 to 3 days was a time saving and fairly accurate tool. Conditions regarding habitat, environmental temperatures and vectors should also be accounted for in the interpretation of results. To study the cold tolerant spoilage population encountered on a certain habitat (*e.g.* meat), it seems advisable to do the quantitative survey at 7 °C and further studies on the isolates could be done at 20 °C to 25 °C.

The non-integrated South African production system of abattoirs, wholesalers and retailers, yielded microbial results at retail, which in most cases compared fairly to those reported in literature. Different surfaces including personnel surfaces (hands and apron fronts) and equipment (mincers and saws) were not sanitised with the same efficacy. Using selective media Enterobacteriaceae, enterococci, micrococci *Pseudomonas* and *B. thermosphacta* counts described 96 % of the variation in the psychrotrophic count at the abattoir, while the use of these counts for estimating the psychrotrophic count at the wholesaler and retailers was not as reliable. At the abattoir the Enterobacteriaceae and pseudomonads were the biggest contributors to the psychrotrophic count, at the wholesaler the Enterobacteriaceae and micrococci counts and at the retailers the micrococci and pseudomonads. The psychrotrophic and enterococci counts from a shelf life study compared favourably with results reported by other workers, while the Enterobacteriaceae and micrococci counts were higher.

Identifying psychrotrophic isolates it was shown that microbes developing on chilled meat could also be isolated from other surfaces in the production chain. Pseudomonads are the dominant organisms on chilled meat followed by the Gram-positive cocci (*Staphylococcus* and *Micrococcus* spp.). At the wholesaler *Staphylococcus* and *Micrococcus* spp. and at the abattoir pseudomonads dominated the population, followed by *Acinetobacter, Moraxella* and *Alcaligenes* spp. and then *Staphylococcus* and *Micrococcus* spp. Pseudomonads, *Acinetobacter, Moraxella, Alcaligenes, Staphylococcus, Micrococcus,* species from the coryneform groups of bacteria and yeasts were identified from most surfaces monitored. Enterobacteriaceae and Vibrionaceae represented were *Citrobacter* (1), *Klebsiella* (3), *Enterobacter* (19), *Serratia* (1), *Vibrio* (2), *Aeromonas* (2), *Chromobacterium* (3) and *Pasteurella* (4). Vibrionaceae were not recovered from surfaces at the retailers, while *Salmonella* spp. were not found. Enterobacteriaceae, lactobacilli and endospore forming bacteria were identified occasionally, but their significance as contaminating organisms seems low.

Pseudomonas spp. are dominant in the microbial population association with carcasses and fresh meat as well as on hands and clothes at the abattoir, on hands at the wholesaler and on hands, clothes and mincing machines at the retailers. The identification of *Pseudomonas* spp. by means of the API NE20 system could only be used as a conformation of genera already identified by other means. Non-pigmented organisms accounted for more than 75 % of the pseudomonads isolated, with fluorescent isolates representing only approximately 5,5 % and *P. aeruginosa* strains 8,7 % of the total pseudomonad population.

The results re-emphasised the multi-factorial complexity of fresh meat quality and shelf life. The microbial quality of the raw material (carcasses), the maintenance of the cold chain, sanitary condition of premises, equipment and personnel surfaces and general management practices are factors determining the microbiological quality of the product.

MILK

- *Microbiology*

VS.3123/08/1/2: RAPID TESTS FOR THE BACTERIAL EVALUATION OF MILK. 1983-1986
W.C. Botha

The application of the DEFT as a rapid bacteriological platform test was investigated. Both single cells and clumps of cells were counted and compared to the standard bacterial count. When compared to the standard bacterial count, the DEFT single cell count showed a stronger correlation ($r = 0,68$; $n = 96$) than the DEFT clump count ($r = 0,64$; $n = 96$).

The DEFT single cell count, however, differs significantly from the standard bacterial count. The DEFT clump count is recommended for uses as a rapid bacteriological platform test which is able to identify milk with a high bacterial count (>200 000 bacteria/mℓ).

MILK

• *Microbiology*

VS.3123/08/1/9: COMPARISON OF THE BATERIOLOGICAL QUALITY OF BULK-COOLED INDUSTRIAL MILK WITH THAT OF MARKET MILK. 1985-1986

H. Lück

The bacteriological quality of bulk-cooled manufacturing (industrial) milk and market (fresh) milk was compared by testing samples of raw farm milk (200 samples each), samples taken from road tankers (200 samples each) and samples of pasteurised milk, for total bacterial count, psychrotrophic count, coliform count, laboratory pasteurisation count and the number of acid forming and non-acid forming mesophiles.

The bacteriological quality of fresh and industrial milk taken from farm tanks and after pasteurisation was similar. There is, therefore, no logical reason why bulk-cooled industrial milk should not be used for the manufacture of UHT milk, cultured milks, cottage cheese, etc.

Tanker milk (fresh and industrial milk) contained 1,3 to 6,5 times higher total counts than farm milk.

DAIRY PRODUCTS

• *Microbiology*

VS.3124/08/2/3: CONTROL OF INSECT INFESTATION DURING STORAGE OF DAIRY PRODUCTS. 1984-1986

H. Lück

During fumigation with phosphine gas (theoretical conc. 2 g PH_3/m^3) the gas did not only penetrate densely packed commodities (maximum 730 mg/kg air) but also conventionally closed bags of dried milk.

The following insects were found in milk powder: *Tribolium castaneum* (red flour beetle), *Tribolium confusum, Stegobium paniceum* (drug store beetle and *Lassioderme serricorne* (cigarette beetle). The mites identified from cheese stores were of the genus *Tyrophagus* (mainly *Tyrophagus longior*). The beetles were easily eradicated at 20 to 25 °C while the mites could only be eliminated for a limited period of time (*ca.* 3 months). Mites could not be eradicated at a temperature of 15 °C. Two weeks after fumigation the PH_3 residue content of cheese and milk powder was below the maximum residue limit of 0,01 mg/kg.

DAIRY PRODUCTS

• *Technology*

VS.3214/52/1/3: DAIRY PRODUCTS: THE HYDROLISATION OF WHEY PROTEINS. 1981-1987

B.G. Venter

A study was undertaken to investigate the influence of enzymic hydrolysis on the functional properties of whey proteins. For this purpose a whey protein concentrate (WPC) containing 75 % protein (Kjeldahl N x 6,38) was manufactured using ultra-filtration. Two non-specific, commercial, food grade, proteolytic enzyme preparations, Alcalase^R and Neutrase^R, were employed for the hydrolysis of the whey proteins under varied conditions of pH and temperature. The hydrolysis conditions were maintained constant using pH stats and stirrer heaters fitted with contact thermometers and the hydrolyses monitored by base consumption. Hydrolyses employing Alcalase^R were performed at pH 6,8; 7,8 and 8,8, and temperatures of 40; 50 and 60 °C, at each pH value. The influence of neutrase was studied under steady-state conditions of pH 7,0 and 40 °C, at varying enzyme concentration.

Empirical, model tests were used to assess the functional properties of the intact whey proteins as control sample. Egg white, egg yolk and gelatin were used as reference samples, as well as the derived whey protein hydrolysates. During the five hours' run of every hydrolysis, hydrolysate samples were withdrawn from the reaction mixtures and allotted to the evaluation of certain functional properties. In this way a

means of continuous monitoring of changes in the functionality of the whey proteins, as a function of progressive enzymic hydrolysis, was effected. The properties assessed in this regard were nitrogen solubility, heat denaturedness, water binding capacity, gel strength, emulsifying capacity and foaming power.

Observed differences in functionality between hydrolysates of similar degrees of hydrolysis, suggested the formation of structurally different hydrolysates under varied conditions of pH and temperature. Definite trends were, however, observed regarding changes in the functional performance of the whey proteins with progressive hydrolysis. The changes affected by the actions of the two enzymes, although both are non-specific in their actions, were not necessarily similar. Nevertheless, the trends observed and their magnitudes, were dependent on the hydrolysis conditions employed.

Initial increases in the foaming power and emulsifying capacity of the WPC hydrolysates were observed, but with concurrent decreases in foam stability, water binding capacity and gelling ability - the first and last properties of the hydrolysates being totally lost. Observations recorded for the nitrogen solubility and heat denaturedness of the WPC hydrolysates were not essentially complementary, as was theoretically expected. During the latter stages of hydrolysis the observed initial increases in the functionality of the WPC hydrolysates were suppressed, resulting in severe decreases. Differences were, however, noted in the changes imposed by the two enzymes.

Considering that the study was not undertaken to evaluate model tests for the assessment of protein functionality, it must be concluded that before such tests are standardised, no meaningful comparisons between results can be made, nor can trends observed be interpreted as reflecting the true course of functionality changes imposed by proteolysis of whey proteins. This makes it difficult to assess accurately the true commercial value of such products.

DAIRY PRODUCTS

- *Technology*

VS.3124/52/1/12: THE MANUFACTURE OF CASEIN AND CASIENATES WITH EXISTING CHEESE MAKING AND SPRAY DRYING EQUIPMENT. 1985-1987

T.E.H. Downes

Because of the inconsistancy of surplus skim milk supplies in S.A., the capital investment required to create a specialised casein and casienate production unit cannot be justified. The possibility of producing these products on existing facilities was, therefore, investigated.

By a method of increasing the skim milk's total solids from CA 9 % to 17-18 %, by evaporation, a firmer casein curd was produced which reduced losses of fine curd particles and almost doubled the yield per batch. The concentrated skim was acidulated with 2 % lactic acid culture, plus 0,4 g rennet per 1 000 ℓ at a temperature of 24 °C for 16 hours. The resultant curd was firm enough for cutting at a pH of 4,9. After cutting the curd it was heated to a temperature of 50 °C with gentle agitation, at which stage the whey was drained and wash water added at 50 °C. After CA 10 minutes of washing with gentle agitation, the wash water is drained and a second wash at this temperature carried out. A final pasteurisation wash was carried out at 65 °C for 30 minutes.

The casein curd is then milled by a colloid mill and dried as casein or caseinate in a slurry form with CA 20 g solids.

This method was tested in a commercial factory and found to be so satisfactory that it was used to produce 130 tons of the products during the short period that surplus skim was available. This quantity was worth R780 000 which was saved in foreign currency. Unfortunately there is now a shortage of skim so that at least 3 000 tons worth R18 million will be imported annually until skim is again in surplus.

DAIRY PRODUCTS

- *Chemistry*

VS.3124/53/3/1: DAIRY PRODUCTS: METHODS TO DETERMINE THE DEGREE OF ADDED MILK POWDER TO BREAD. 1981-1987

L.E. Smit

A comparison between the standard copper reduction, chloramine T and a modified high performance

liquid chromatographical method (HPLC) was carried out on milk and milk products for the determination of lactose. Statistically it was found that accuracy of quantification by the HPLC method, equals that of the copper reduction and chloramine T methods. The HPLC method was used for lactose recovery tests in milk and was found to be satisfactory with regard to total recovery of the lactose (102 to 107 %).

DAIRY PRODUCTS

• *Chemistry*

VS.3124/53/3/2: LEVELS OF LINOLEIC ACID (TRANS) IN DAIRY PRODUCTS AND OILS, BEFORE AND AFTER PROCESSING. 1981-1986

A.L. Malan

The use of *Tetrahymena pyriforms* W as a rapid and cost effective method for the evaluation of the protein quality of dairy products, especially whey products and powders, was investigated. It was found that while the assay was both reliable and repeatable in the long term it was not reliable as a one-off test.

Further the reliability of the method with regard to whey powders is questioned as RNV's which were far less than expected were consistently obtained. A modified calculation method based on the actual growth dynamics of the organisms is proposed.

Supporting animal research

ANIMALS

• *Reproduction*

VS.3133/04/1/1: THE EARLY IDENTIFICATION OF FEMALE ANIMALS PRONE TO ABORTION, USING A *IN VITRO* ANALYTICAL TECHNIQUE. 1982-1987

G.W. Kay

A technique which has been used to monitor the toxicity of serum of cancer patients receiving chemotheropy and of monkeys prone to abortions, has been adapted for the testing of cattle serum, with the aim of identifying poor breeders. The technique entails the culturing of rat embryos in the test-serum and the subsequent monitoring of brain development and neural tube closure.

Using serum from normal fertile cows resulted in rapid embryonic growth and organ development. Of the embryos showing good growth, 87 % demonstrated symmetrical brain development and various degrees of neural tube closure. The remaining 13 % of embryos showing good growth, demonstrated asymmetrical brain development and could be regarded as false positive results.

Large-scale application of the test was not possible as all reliable sources of test-sera (complete documentation of the reproductive history of the animal) had slaughtered their animals which tended to abort, in the face of the prevailing drought. The technique is now being utilised to monitor the teratogenicity of serum from sheep consuming trace levels of lead and copper.

ANIMALS

• *Nutrition*

VS.3133/05/1/16: FIBRE-DIGESTING BACTERIA IN THE RUMENS OF SHEEP FED MAIZE STRAW AND INCREASING AMOUNTS OF MAIZE GRAIN, IN RELATION TO THE DIGESTION OF CELLULOSE AND HEMICELLULOSE. 1979-1986

N.O. van Gylswyk

This work was carried out to establish whether decline in intake of fibre when roughage is supplemented with readily fermentable carbohydrates is due to a decrease in ruminal fibre-digesting bacteria.

In the first phase 12 Merino wethers fitted with rumen fistulae were fed maize straw *ad lib* supplemented with protein-mineral mixture at the rate of 135 g/kg of straw eaten. In the second phase one sheep was kept on this diet while each of the others was allocated to a different diet in which straw and protein-mineral mixture were supplemented with maize grits pellets (90, 120, 150, 180, 210, 240, 270, 300, 330, 360 or 390 g/kg of total diet). All diets contained 13,8 % crude protein.

Straw intake and the amount of cellulose and hemicellulose digested per hay declined progressively with increasing grain supplementation. Retention time of solids in the rumen decreased. However, numbers of total culturable, cellulolytic and active xylanolytic bacteria per g rumen ingesta did not change significantly with grain feeding. The predominant cellolytic rumen bacterium was *Ruminococcus albus* followed by *Ruminococcus flavefaciens* and *Butyrivibrio fibrisolvens* with all the diets. The same species were found to be the major hemicellulolytic (xylanolytic) bacteria but *B. fibrisolvens* was the most numerous followed by *R albus. Bacteroides succinogenes*, reputed to be and important cellulolytic species, particularly when feeding high roughage diets was not found because the methods used were not suitable for its detection. Accordingly two sheep used in the above experiments were fed firstly the grain-free diet followed by a diet containing the highest proportion of grain as was used previously. A method suitable for obtaining counts of *B succinogenes* gave results which showed that this species was more abundant in the rumen than *R. albus* among the cellulose-digesting bacteria irrespective of whether the maize straw was supplemented with maize grain. Numbers of *B. succinogenes* per g ingesta were higher when the sheep were fed the grain-supplemented diet. At least two other groups of workers had obtained a similar result with different roughages.

An examination of the large number of isolates of fibre-digesting bacteria obtained during the course of this work indicated that there were several hemicellulolytic ones that appeared to belong to species not described before. These were studied extensively. It was found that among them there were two new species of *Eubacterium*, apparently indigenous to the rumen. A xylanolytic clostridium was also studied in detail and was subsequently found to be a new species. It was suspected that clostridia are not normal inhabitants of the rumen. In order to establish this for our isolates, samples of maize straw from the batch fed to the sheep were examined. Among the isolates obtained from the incubated straw were ones that belonged to the same species found in the rumen. A species of cellulolytic clostridium which had been isolated from the rumen in this work as well as during work on an earlier project in which sheep were fed maize straw was also isolated from the straw. This tends to confirm that clostridia in the rumen are not indigenous to the ruminal environment. In fact, unlike typical rumen bacteria, they are able to grow at temperatures well below body temperature.

ANIMALS

• *Nutrition*

VS.3133/05/2/5: ASPECTS OF PROTEIN NUTRITION IN FARM ANIMALS: LUCERNE PROTEIN CONCENTRATE FOR THE MONOGASTRIC ANIMAL.
1984-1987
F.K. Siebrits

The aim of this study was to evaluate lucerne protein concentrate (LPC) coagulated by means of steam or hot water. The two types of LPC were prepared by either adding the lucerne juice to hot water (85 °C) or by injecting steam until the juice reached a temperature of 85 °C after which the coagulum was freeze-dried. The resulting water- and steam-coagulated LPC had a protein content of 54,5 and 49,9 % and a lysine content of 3,22 and 2,92 %, respectively on an air-dry basis.

The quality of the protein concentrates was determined by using the relative nutritive value (RNV) assay as well as *in vivo* true protein digestibility (PTD) with male Wistar rats. Body protein accretion was used as the measure of response to dietary protein and lactalbumin was used as the reference protein.

The RNVs of lactalbumin, water-coagulated and steam-coagulated lucerne LPC were respectively, 1,0 0,573 and 0,397, whereas the PTD was respectively, 97,6; 80,9 and 76,7 %.

All the rats on the water-coagulated lucerne LPC diet showed symptoms of photosensitivity namely loss of hair and skin lesions in the form of blackening of ear rims. Three rats even sloughed their ears. This phenomenon was probably due to chlorophyllides and pheorforbides which are derivatives of chlorophyll owing to the action of a chlorophyllase enzyme which escaped damage at the lower coagulation temperature.

It was concluded that, until it can be established that unpigmented farm animals (pigs and poultry) are insensitive to pheoforbides and chlorophyllides, steam coagulation should remain the process of choice, despite the fact that the water-coagulated LPC was nutritionally superior.

Subsequently, enough water-coagulated LPC was prepared to feed 12 piglets (5 weeks of age) for a period of 3 weeks on diets containing 0, 8, 12 or 16% LPC. The LPC replaced equal amounts of soybean oil-cake meal. No significant differences in growth rate or feed conversion were observed. Two piglets on the 16% LPC diet and 2 on the control diet were examined histologically for possible liver lesions. No differences were found so that it was concluded that pigs are not as sensitive to chlorophyll derived compounds as rats are.

ANIMALS

• *Nutrition*

VS.3133/05/3/13: DIGESTIVE PHYSIOLOGY AND METABOLISM ASPECTS IN FEEDING OF FARM ANIMALS: TISSUE LIPOGENIC PRECURSORS. 1981-1987

J.M. Gooden, S.L. Campbell and J.G. van der Walt

Measurement of blood flow and lipolysis in the hindquarter tissues of the fat-tailed sheep *in vivo*

The potential of Karakul and Namaqua-Afrikaner sheep, which possess tails consisting largely of adipose tissue, as suitable models for the *in vivo* investigation of lipid metabolism was investigated. The anatomy of the blood supply to the hindquarters of both breeds was examined and a technique was developed for sampling the venous outflow from the fat tail.

The composition of the skin, the tail and the rest of the hindquarters was determined after estimating blood flow rates through the whole hindquarters of both breeds, as well as the hindquarter adipose and muscle tissues of Karakul ewes using 2 dye-dilution techniques. The composition of the hindquarters was similar in both breeds, containing 35% fat, about half of which was located in a tail consisting almost entirely of adipose tissue (72-74% fat). The specific blood flow rate through tail adipose tissue (3,62 ± 0,12 mℓ min^{-1} per 100 g) was about 45% of that through hindquarters muscle tissue, and about 34% of that through skin.

When flow rates through the hindquarter tissues of the Karakul ewe were expressed in absolute values, about half the total hindquarters flow passed through the muscles, 20% through the adipose tissue and 22% through the skin. The sum (Mean ± SD) of these absolute flow rates was statistically indistinguishable from the directly measured value derived from the corrected partition coefficient for the entire hindquarters (729 ± 109 and 794 ± 227 mℓ min^{-1}, respectively). The p-amino hippuric acid method gave values for the absolute blood flow rates (Mean ± SEM) through the entire hindquarters of Karakul ewes that were similar to those obtained from the tritiated water method, namely 794 ± 131 and 761 ± 50 mℓ min^{-1}, respectively.

Although the total blood flow through the hindquarters of Namaqua-Afrikaner ewes (626 ± 39 mℓ min^{-1}) was found to be somewhat lower than that measured in the Karakul ewes, the difference was not significant at the 10% level. Both breeds were therefore found to be ideal models for the *in vivo* investigation of lipid metabolism.

Entry rates of acetate and free fatty acids and their interconversion in the hindquarters of fat-tailed lambs

The effect of halving *ad libitum* feed intake on whole-body turnover and hindquarters flux of acetate and free fatty acids (FFA) was determined in Karakul lambs fed a pelleted diet containing 68% lucerne hay, 18% ground maize, 10% molasses and 2% fishmeal. Uptake, production and interchange between acetate and FFA were determined for muscle and adipose tissue. Catheters were placed in the posterior aorta, vena cava, lateral saphenous and jugular veins. 1-(^{14}C) acetate and 1-(^{14}C) FFA were separately infused, and blood analysed for the concentration and specific activity of acetate and FFA. Blood flow rates through the hindquarters and related muscle tissue were simultaneously determined using the tritiated water technique.

Blood flow rates of 64 ± 4 and 83 ± 5 mℓ min^{-1} kg^{-1} for whole hindquarter and muscle tissue, respectively, were found. Acetate concentration in blood from the aorta, vena cava and lateral saphenous (1 132, 672 and 726 uM, respectively) declined significantly during half *ad libitum* feeding to 661, 427 and 485 uM. FFA concentration did not change significantly during this period. Whole-body entry rates of acetate and FFA were significantly changed by restricting intake (90 ± 13 to 41 ± 5 and 4,8 ± 0,3 to 10,3 ± 0,1 mmol h^{-1}, respectively). In the fed sheep, about one third of the acetate flux was directly incorporated into FFA, while negligible amounts of acetate were formed from FFA. As a result, about two thirds of the FFA pool were directly derived from acetate.

Restricting intake reduced the contribution of acetate to only 16 %, while the amount of acetate now derived from FFA increased to 25 %. Thus, the contribution of acetate to FFA synthesis was reduced to less than 10 %. Net uptake of acetate by the hindquarters (20 % of whole-body flux) was reduced by restricting the feed intake, while the net production of FFA was increased. Muscle utilised about 50 % and 40 % of the acetate and FFA, respectively that were taken up by the hindquarters. More than 4 mmol h^{-1} of FFA were produced by adipose tissue in the hindquarters, regardless of level of intake.

Effect of noradrenalin on lipogenesis and lipolysis in the hindquarters of lactating and dry fat-tailed ewes, measured *in vivo*

Permanently-indwelling PVC catheters were inserted, 2-3 weeks prior to term, into the jugular vein, and the posterior aorta and vena cava of pregnant, fat-tailed Namaqua-Afrikaner ewes that were fed *ad libitum*. The lambs were removed shortly after birth and the ewes hand-milked twice daily for 4-6 weeks.

Rates of plasma flow through the hindquarters were measured in ewes that were dry or in peak lactation, in both the fed and the fasted state. Basal and noradrenaline-stimulated rates of lipolysis and lipogenesis were estimated from arteriovenous differences in concentration of glycerol and free fatty acids (FFA) determined concurrently with plasma flow rates. Plasma flow through the hindquarters of fed, dry ewes was 4,83 ± 1,29 mℓ min^{-1}/100 g. Similar values were obtained during peak lactation, as well as after fasting. Intravenous infusion of noradrenaline significantly (PF 0,10) increased plasma flow by about 60 % in all cases. Net production of glycerol by the hindquarters of fed and fasted ewes, whether dry (0,68 ± 0,11 and 1,15 ± 0,24 mmol min^{-1}/kg, respectively) or lactating (1,55 ± 0,27 and 1,40 ± 0,04 mmol min^{-1}/kg, respectively), was always increased by infusion of noradrenaline, 5 to 6-fold in fed and 3-fold in fasted ewes.

Basal and noradrenaline-stimulated net production of glycerol was generally higher in lactating than in dry ewes, significantly so (PF 0,10, Student's t test) in fed ewes (1,55 ± 0,27 and 9,32 ± 1,87 compared to 0,68 ± 0,11 and 3,54 ± 0,51 mmol min^{-1}/kg respectively). Net flux of free fatty acids (FFA) by the hindquarters followed a pattern similar to that found for glycerol, except in the case of the dry, fed ewe group in which a net amount of FFA was taken up by the hindquarters (3,55 ± 1,16 mmol min^{-1}/kg). Rates of reesterification, which were low in fed and fasted lactating ewes and fasted dry ewes, (1,54 ± 0,4, 1,89 ± 0,35 and 0,67 ± 0,14 mmol min^{-1}/kg, respectively), were considerably increased by noradrenalin infusion (10,78 ± 3,4, 6,11 ± 2,47 and 4,69 ± 1,85 mmol min^{-1}/kg, respectively). Reesterification rate in fed dry ewes was similar in magnitude to the noradrenalin-stimulated rate (5,59 ± 1,09 and 6,33 ± 2,36 mmol min^{-1}/kg, respectively).

Individual milk production was proportional to the increase in ME intake during peak lactation, and to the basal rate of lipolysis. However, the capacity of the ewe to respond to noradrenaline was inversely proportional to milk production and basal lipolysis.

ANIMALS

• *Nutrition*

VS.3133/05/4/5: DETERMINATION OF THE OPTIMUM TREATMENT CONDITIONS FOR THE AMMONIATION OF GRAIN SORGHUM. 1986-1987

J.P. Swiegers

A 2 x 2 x 2 x 4 factorial experiment was conducted to determine the effect of physical form (whole or milled), dry matter content (800 and 900 g DM/kg) and ammonia concentration 0; 7,5; 15,0; 30,0 g NH_3/kg DM) on the 18 hour *in vitro* digestibility and tannin content of high (HTS) and low tannin (LTS) grain sorghum.

Ammoniation of HTS at the 1,5 % ammonia level highly significantly decreased ($P < 0,001$) the tannin content to a level similar ($P > 0,3$) to that of LTS with a highly significant ($P < 0,01$) increase in the *in vitro* OM digestibility. A highly significantly higher ($P < 0,01$) *in vitro* digestibility was also obtained with untreated LTS in comparison to that of untreated HTS.

A highly significant ($P < 0,05$) sorghum type x physical form interaction was found in *in vitro* digestibility, which implicates that a positive effect may be obtained when LTS is ammoniated in the milled form. Physical form apparently did not affect the efficiency of ammoniation of HTS. Although a higher moisture content decreased the tannin content of HTS ($P < 0,01$) it had no effect on *in vitro* digestibility. It is thus evident that HTS and LTS differ with regard to the conditions required for their maximum response to thermal ammoniation. The responses obtained with HTS is apparently mainly related to a lower tannin content.

• *Nutrition*

VS.3133/05/4/6: CROP RESIDUES AND WASTE PRODUCTS IN ANIMAL FEEDING: EFFECT OF LEVEL OF CONCENTRATE INCLUSION ON THE UTILISATION OF UNTREATED AND THERMO-AMMONIATED GRAIN SORGHUM STRAW BY RUMINANTS. 1986-1987

J.P. Swiegers

A digestibility experiment was conducted to determine:

1. The effect of 6 levels of concentrate inclusion on fibre digestibility of ammoniated grain sorghum straw relative to that of untreated straw.
2. The effect of these concentrate levels on ME intake of the total diets.
3. The effect of ammoniation on the utilisation of grain sorghum straws.

Thirty-two S.A. Mutton Merino lambs were randomly allocated to 12 experimental diets containing either ammoniated or untreated grain sorghum straw with 12, 24, 37, 50, 62 and 74 % maize meal in both treatments. Feed and feaces samples were analysed for gross energy, nitrogen and neutral detergent fibre (NDF) in order to determine the apparent digestibility coefficients of the experimental diets.

Ammoniation tended to decrease DM intake although the difference was only significant at the 12 % concentrate level. The main effects of intake of untreated and ammoniated diets were 1 340 and 1 139 g/day, respectively (p=0,0078).

Concentrate inclusion tended to increase intake at the 25 % level above that of the 12 % concentrate level. Additional concentrate inclusion resulted in a linear decrease (R^2=0,97) in DM intake.

Ammoniation had no significant positive effect on apparent energy and NDF digestibility coefficients. The main effects of apparent energy digestibility were 65,93 and 64,98 % for untreated and ammoniated diets, respectively. Concentrate inclusion resulted in a linear increase (R^2=0,97) in apparent energy digestibility. When observed and expected digestibility coefficients were subjected to a Chi Square test the difference were not significant (P=0,814) indicating that no significant associative effects occurred.

The maximum digestible energy intake was obtained at the 50 and 62 % concentrate inclusion levels with a significant decrease at the 74 % level compared to that at the 50 and 62 % level.

• *Genetics*

VS.3133/06/1/8: LABORATORY ANIMALS IN GENETIC STUDIES: LIFETIME GROWTH - RATS. 1981-1987

M.M. Scholtz

Seasonal changes have been found in the lifetime growth rate (ADG) of rats (173 %) and are associated with the longest and shortest days of the year. During the spring period (July-December) ADG was much higher than in the autumn period (January-June), while there was no differences in intake. Significant differences between seasons were also found in efficiency of feed utilisation (229 %).

This aspect was also investigated in Simmentaler and Brahman cattle. During the spring period the feed conversion ratio (FCR) of the Simmentaler was 6,70 compared to 7,35 of the Brahman. In the autumn period, however, the FCR of the Brahman was 6,78 comparerd to 7,11 of the Simmentaler. It is postulated that these seasonal patterns may be explained by the evolutionary history of the rat and the two cattle breeds. There may be an evolutionary advantage for animals to utilise feed more efficiently during natural periods of nutritional shortages.

A comparison between the economics of optimum and maximum reproduction were made, using the rat as model. The percentage difference between the maximum and optimum reproduction groups for a

number of characteristics were as follows:

age at first litter	12,5 %
number of litters	50,0 %
litter size at birth	0,0 %
litter size at weaning	20,4 %
litter mass at weaning	41,4 %
female mass	1,4 %
total feed intake	5,1 %
feed required/litter mass at weaning	0,2 %
feed required/biomass (litter and female mass)	0,7 %

From these results it is evident that the difference between groups in terms of feed required/biomass was virtually non-existant and there seems to be no economic difference between the two systems.

VETERINARY RESEARCH

Food hygiene

ANIMAL FOOD

• *Pathology*

OP.3221/19/1/8: AN INVESTIGATION ON THE METABOLIC ACTIVITY AND ISOTOPE LABELLING OF SOMATIC CELLS SEPARATED AND PURIFIED FROM BLOOD AND UDDER SECRETION OF NORMAL AND MASTITIC DAIRY COWS. 1984-1986

Z.E. Kowalski

Different types of bovine udder secretions were investigated for the purpose of assessing the general feasibility of tentative determinations on fibrinolysis and related activities in such secretions.

Clinically normal udders

Milk from clinically normal udders showed neither plasmin nor non-specific proteolytic activity. However, the secretions differed in their PA activity, which was negative, inconclusive and positive in 6, 8 and 6 of the milk samples, respectively.

Clinically mastitic udders

An evaluation similar to the former evaluation of results from samples of clinically mastitic udders suggested that 17 and 3 of the secretions showed either no or inconclusive plasminogen incidence, respectively, whereas all of them were negative for non-specific proteolytic activity. Compared with the samples from clinically normal udders, none of those from clinically mastitic ones were negative, but they were less frequently inconclusive (3x) and mostly positive (17x) for PA activity.

Dried-off udders

Secretions from dried-off udders indicated inconsistent patterns of negative and inconclusive plasminogen incidence and non-specific proteolytic acitivity, but, apart from the inconclusive result of sample 1, all were positive for PA activity.

Using the composite fibrin plates method, plasminogen activator (PA) activity was found in secretions from clinically normal, mastitic, lactating and dried-off udders of dairy cows. The possible involvement of the fibrinolytic system in the physiology and pathology of the bovine mammary gland is discussed.

Entomological investigations

EXTERNAL PARASITES

• *Pathology*

OP.3261/19/1/6: EXTERNAL PARASITES: THE INFLUENCE OF TICK CONTROL ON THE EPIDEMIOLOGY OF HEARTWATER. 1983-1987

J.L. du Plessis

Total or intensive *versus* strategic tick control has for some time been a controversial issue. Although it has not been experimentally proven, it has for some time been suspected that intensive dipping holds the risk of compromising the immunity of cattle to heartwater in that too severe a dipping programme, and the consequent eradication of ticks, resulted in insufficient boosting of their immunity through ticks.

In an earlier investigation to determine whether the immune status of cattle can be related to the tick control practised, it was found that there was no correlation between the number of cattle that were serologically positive to *Cowdria ruminantium* and the severity of the tick control to which they were subjected. In this study information regarding tick control, tick loads and the prevalence of heartwater was thought to be inadequate. In a subsequent epidemiological study undertaken on 23 farms where heartwater occurs endemically, the proportion of animals in each herd that had been infected through ticks was determined by means of the indirect fluorescent antibody test, adult *Amblyomma hebraeum* ticks were counted and the *C. ruminantium* infection rate of the ticks determined.

On an overall average antibodies to the heartwater agent were detected in 64,3 % of the cattle (4- to 6-month-old calves and 14- to 18-month-old animals). The seropositivity of the calves as an indication of the rate at which they had been infected through the tick appeared to be related to the numbers of ticks to which they had been exposed. An overall average of 6 ticks per animal was recorded on the 23 farms. On all except one of the 12 farms where a seropositivity below the average for the calves was recorded, tick counts were well below the average of 6 ticks per animal.

An average of 7,0 % of ticks were infected with *C. ruminantium*. The tick infection rate appears to have influenced the percentage of 4- to 6-months-old calves that were immune to heartwater. Some of the farms with the highest percentages of seropositivity were associated with tick infection rates above the 7,0 % and with only 2 exceptions a lower than average infection rate was recorded on all 13 farms where the seropositivity was below the average of 61,5 %.

It was found that the type of tick control practised on the farms was reflected in the immune status of the herds, since low seropositivity was recorded on 10 of the farms where total tick control was practised and where below average numbers of ticks were counted. On all except 3 of these farms the prevalence of heartwater was moderate, whereas on the majority of the farms where strategic tick control was practised, the prevalence was low.

EXTERNAL PARASITES

• *Pathology*

OP.3261/19/1/7: THE DEVELOPMENT OF SEROLOGICAL AND IMMUNOLOGICAL METHODS FOR THE STUDY OF HEARTWATER. 1985-1987

P.T. Oberem

In order to develop a sensitive serological technique for studying *Cowdria ruminantium*, the causative agent of heartwater, it was essential to develop techniques for the purification of the organism as a source of antigen.

Of the various techniques tested, affinity chromatography on a wheat germ lectin column yielded the best results using both tick homogenates and brain tissue as source of the organism. An ELISA test utilising this antigen worked adequately under controlled laboratory conditions, but results in the field were less satisfactory because of to a high background, low sensitivity and variability in the specificity.

With the development of the *Cowdria* tissue culture techniques a new source of antigen became

available. An attempt was made to use the tissue culture material as antigen in the ELISA. Unfortunately, severe non-specific colour changes were a problem due to the antibovine lgG conjugate binding to elements of the bovine endothelial cells in which *Cowdria* is cultured.

During these trials 30 sera from Namibia where heartwater does not occur, were tested. Of these, 74 % were positive raising the possibility that cross-reactions with *Ehrlichia*-like organisms further complicates the interpretation of results. This was later confirmed by other workers using the I.F.A. Test.

In the light of this it was decided that attempts at developing a reliable and accurate ELISA for heartwater field evaluations would be shelved until an improved antigen production technique is developed.

This will require a sound biochemical background and sophisticated equipment beyond the scope of the section of entomology.

Molecular biological investigations

MACRO-MOLECULES

• *Protozoology*

OP.32*12*1/13/1/1: THE CONSTRUCTION AND PARTIAL CHARACTERISATION OF GENOMIC LIBRARIES OF *BABESIA* AND *ANAPLASMA*. 1985-1987

R.E. Ambrosio

Babesiosis and Anaplasmosis are tick-borne diseases of cattle which occur world-wide causing losses totalling millions of rands annually. These diseases are caused by parasites of the genus *Babesia* and *Anaplasma*.

At present there are no methods available to rapidly and reliably diagnose or monitor the presence of these parasites in large herds on a routine basis. Molecular biology and its associated techniques have made the development of such diagnostic procedures feasable. This has led to a programme to develop diagnostic DNA probes for *Babesia* and *Anaplasma* as well as the development of sub-unit vaccines against these parasites.

Genomic libraries containing segments of DNA from *Babesia bovis, B. bigemina, Anaplasma centrale* and *Bos taurus* were constructed in a bacteriophage expression vector, λ*gt*11.

Library construction was preceded by the development of a technique to isolate pure parasite DNA from infected blood. The libraries were constructed by digesting parasite DNA with a restriction endonuclease *Eco*R1, and cloning the digested DNA into the expression vector. After *in vitro* packaging each library was pooled and stored at 4 °C.

Libraries representing the entire genome of the above organisms were obtained, except for *B. taurus* where a 75 % library was obtained. The *A. centrale* and *B. bovis* libraries were screened by immune blotting with hyperimmune serum and positive clones were identified in each case.

Biochemical investigations

BIOCHEMICAL INVESTIGATIONS

• *Virology*

OP.32*13*1/12/1/1: *IN VITRO* ACTIVATION OF TRANSCRIPTASE ACTIVITY WITH BLUETONGUE VIRUS. 1979-1987

A.A. van Dijk and H. Huismans

The primary aim of the project was to develop a suitable procedure for the *in vitro* preparation of bluetongue virus core particles and to study the *in vitro* transcription reaction of bluetongue virus. Characterisation of various subviral BTV particles with regard to transcriptase activity, density, morphology and infectivity as well as an analysis of the product of the *in vitro* transcription reaction was also required.

We developed procedures that allowed us to selectively remove three of the four major structural

proteins of BTV. Virus particles from which protein P2 was removed was called subviral particles. When both proteins P2 and P5 were removed the remaining viral particle was called a core particle, and virions which had lost proteins P2, P5 as well as P7 were called subcore particles. Subviral particles can be prepared *in vitro* by treating BTV virions with chymotrypsin, while core particles are obtained by treatment with a combination of chymotrypsin and specific ionic conditions. These procedures were also found to be applicable to two other orbiviruses, namely African horsesickness virus and epizootic haemorrhagic disease virus. Subcore particles could, however, only be prepared *in vivo* by infecting L-cell cultures, that had been treated not to allow virus replication, and recovering parental viral particles 16-19 h after infection. The removal of protein P7 from core particles coincided with the loss of the typical capsomere structure and showed that protein P7 is the major (if not sole) component of the capsomeres. Subviral particles and core particles are relatively stable, but subcore particles were found to be very unstable.

Transcriptase activity could only be detected in core particles, confirming earlier results reported in the literature that removal of both outercapsid proteins is a prerequisite for the activation of the viral RNA-dependent RNA polymerase. Optimum *in vitro* transcription reaction conditions were determined. The concentration of core particles and the incubation temperature were found to be critical features determining the efficiency of the reaction. It was found that the relatively low temperature optimum of 28 °C for *in vitro* transcription reported previously is not an intrinsic characteristic of the transcriptase, but is due to a temperature dependent inhibition of transcription at high core concentrations. Further investigations revealed that the inhibition is reversible, and that it can be counteracted by compounds such as sucrose, and a low incubation temperature.

The product of the *in vitro* transcription reaction, i.e. the newly synthesised BTV mRNA species was analysed by means of hybridisation and agarose gel electrophoresis. The latter procedure gave an excellent separation of 8 of the 10 mRNA species and made it possible to obtain a reasonable estimate of the molar ratio in which the mRNA species was transcribed, thereby confirming previous indirect evidence that all the BTV double-stranded RNA genome segments are not transcribed in equal relative amounts.

BIOCHEMICAL INVESTIGATIONS

• *Virology*

OP.32*13*1/12/1/2: BIOCHEMICAL INVESTIGATIONS OF THE ANTIGENS AND ANTIBODIES INVOLVED IN THE BLUETONGUE VIRUS IMMUNE REACTION. 1983-1987

N.T. van der Walt

From the existing literature it is clear that vaccination is still the best way of controlling viral diseases. In spite of the successes obtained with the polyvalent vaccine which is currently used it has certain shortcomings, such as inadequate protection against all the sero-types, and teratogenic effects in pregnant ewes. This necessitates the development of an improved vaccine or the use of an alternative vaccine. In this regard it is important to note the promising results that have been obtained with synthetic vaccines against other virus diseases. To investigate this alternative in the case of bluetongue virus (BTV), more information about the antigens and antibodies involved in the immune response against the virus is necessary. This was one of the main motivations for this study.

In order to undertake the necessary immunological investigations several serological tests was adapted for detecting BTV antibodies. This includes the "enzyme linked immunosorbent assay" (ELISA), the immunoprecipitation (IP) test and the immunodiffusion (ID) test.

By removing either P2 or P2 and P5 from the virus particle and comparing the response against the remaining particles with that against the whole virus it was established that either P2 or P5 could carry the neutralisation antigen. By isolating P2 by dissociation from the whole virus it was then shown that this polypeptide could induce neutralising antibodies by itself. It was also shown that immunisation of sheep with isolated P2 could protect them against challenge with virulent virus. This finding shows that a single protein vaccine could be an important alternative to the live attenuated vaccine that is currently in use. Several monoclonal antibodies were also produced against three of the four major proteins of BTV, namely P2, P5 and P7. By using these monoclonal antibodies in serological assays, the serotype specific nature of P2 was confirmed, while it was shown that P5 and P7 had epitopes common to more than one serotype. The localisation of the neutralisation epitope on P2 was also confirmed. Polypeptide P7 was isolated from

infected tissue culture lysates by using a monoclonal antibody against the peptide in an affinity chromatography procedure. In this way the protein can now be isolated for biochemical characterisation and for use as reagent in serological tests such as the ID test. The result obtained also underlines the importance of this method when the isolation of other BTV polypeptides is considered.

BIOCHEMICAL INVESTIGATIONS

• *Virology*

OP.32*131*/12/1/3: BIOCHEMICAL INVESTIGATIONS OF THE STRUCTURAL PROTEINS OF BLUETONGUE VIRUS. 1981-1987

M. Cloete

The aim of this investigation was to isolate and purify one or more of the outer capsid proteins of bluetongue virus, and to obtain more information about the chemical and biochemical properties of the structural proteins.

The effect of both monovalent and divalent cations at different pH levels on the dissociation of outer capsid proteins from the bluetongue virus (BTV) particle was investigated. It was found that the neutralisation-specific antigen of BTV, P2, could be selectively isolated from the virus particle, or together with the other outer capsid protein, P5, depending on the pH and the divalent or monovalent cation concentration. The isolated P2 was still contaminated with a small amount of cellular proteins and trace amounts of P7, which could not be removed by column chromatography. In another project (OP.32*131*/12/1/2) isolated P2, that was purified for immunological investigations by immune adsorption using an anticore serum, was able to elicit neutralising antibodies in sheep. It was found that P2 is the cell-adsorption protein of BTV since viral particles from which P2 had been removed were unable to attach to the cells. These results illustrate the importance of P2 in the replication and infectivity of BTV.

The structural proteins were characterised by the determination of their iso-electric points. The amino acid composition of P2 was determined.

BIOCHEMICAL INVESTIGATIONS

• *Virology*

OP.32*131*/12/1/4: BIOCHEMICAL INVESTIGATIONS OF THE NON-STRUCTURAL PROTEINS OF BLUETONGUE VIRUS. 1981-1987

H. Huismans and A.R. Bauskin

Very little is known about the properties of non-structural proteins in the orbivirus genus and even less about the role of these proteins in virus replication. The aim of this investigation was to characterise non-structural protein NS2 of bluetongue virus (BTV) by investigating the purification and phosphorylation of this protein as well as by studying its affinity for single-stranded RNA. Another objective was to clone the gene of BTV that codes for the synthesis of NS2.

It was found that NS2 is synthesised throughout the infection cycle of the virus in fairly large amounts. The protein can be detected in both the soluble and particulate fraction of infected cells. The particulate NS2 is solubilised in 0,5 M NaCl and can be purified by affinity chromatography on poly(U)-Sepharose. The purified NS2 preparations contain only trace amounts of a few cellular proteins.

It was found that NS2 in the particulate and soluble fraction can be phosphorylated in both an *in vivo* and an *in vitro* reaction. The kinase has not yet been identified but all attempts to separate the kinase activity from NS2 were unsuccesful. NS2, purified by affinity chromatography, can therefore still be phosphorylated *in vitro* without addition of exogenous protein kinase. This result could indicate autophosphorylation but the possibility that a cellular kinase co-purifies with NS2 can by no means be excluded.

The genome segment of bluetongue virus that codes for the synthesis of PS2 has been cloned in an *E. coli* vector, pBR322. Preliminary sequence analysis indicates that the 5' and 3' terminal ends have been fully cloned indicating that a full-length copy of the gene has been obtained. The gene has been hybridised to

dsRNA from different bluetongue virus serotypes and was shown to belong to the group of more highly conserved genome segments. It is, however, more variant than the gene that codes for the other major non-structural protein NS1.

BIOCHEMICAL INVESTIGATIONS

• *Virology*

OP.32*13*1/12/1/5: BIOCHEMICAL INVESTIGATIONS OF THE SYNTHESIS OF BLUETONGUE VIRUS PROTEINS IN CELL-FREE SYSTEMS. 1981-1987

A.A. van Dijk and H. Huismans

The primary aim of the project was to synthesise bluetongue virus proteins *in vitro* in order to determine the protein coding assignments of the double-stranded RNA genome segments, investigate post-translational modifications of viral proteins, and identify regulatory aspects of the translation process of bluetongue virus.

It was found that bluetongue virus proteins could be synthesised *in vitro* in the rabbit reticulocyte lysate system. Both BTV mRNA species as well as denatured double-stranded RNA genome segments were suitable templates for *in vitro* translation. All seven previously identified structural proteins and two non-structural proteins were faithfully synthesised. Three additional non-structural proteins (NS3A, NS3B and NSX) with molecular masses of 28K, 25K and 16K, respectively were identified. The protein coding assignments for the medium- and small-sized double-stranded RNA genome segments of BTV type 10 was determined. It corresponded to that reported in the literature for BTV type 1. Indications were found that at least two of the genome segments seem to possess overlapping reading frames allowing them to specify two proteins each. Segments 4, 5, 6, 7 and 8 encode proteins P4, NS1, P5, P7 and NS2, respectively. Segment 9 codes for protein P6 and probably also for protein NSX. Genome segment 10 also codes for two proteins, namely NS3A and NS3B. Protein NS3B appears to be a truncated form of NS3A since its peptide map completely overlaps that of NS3A. The relative molar ratio in which the viral proteins are syntesised *in vitro* differed from that observed for proteins synthesised in infected cells. *In vivo*, protein NS1 is the most efficiently translated protein. Protien P6 on the other hand is translated much more efficiently *in vitro* than *in vivo*. These findings are in agreement with previous reports implicating a regulatory mechanism involved in the synthesis of BTV proteins, and requires a more comprehensive investigation.

With regard to post-translational modifications of BTV proteins it was established that protein NS2 from infected cells could be phosphorylated *in vitro*. However, no phosphorylation of *in vitro* synthesised NS2 has as yet been accomplished and neither has it been possible to identify the kinase involved. *In vitro* synthesised NS2 did have affinity for single-stranded RNA though, similar to its *in vivo* synthesised counter-part.

BIOCHEMICAL INVESTIGATIONS

• *Virology*

OP.32*13*1/12/1/6: BIOCHEMICAL INVESTIGATIONS: CLONING OF THE BLUETONGUE VIRUS GENOME SEGMENTS. 1984-1987

H. Huismans and M. Cloete

The 10 double-stranded (ds) RNA genome segments of bluetongue virus (BTV) code for the synthesis of at least 7 structural and 3 non-structural polypeptides. The aim of this investigation was to clone the different genome segments into a plasmid vector and to use these clones for investigating the genetic heterogenicity amongst cognate genes in the BTV serogroup. The study should indicate the most suitable serotype-specific and group-specific probes for the detection of virus RNA.

The 7 largest genome segments of BTV4 and an equal number of BTV10 genome segments were cloned in pBR322. Together these clones represent copies of all 10 dsRNA segments. The method used for cloning included both a shot-gun approach and the cloning of individual genome segments. A method was developed

to size cDNA transcripts on alkaline sucrose gradients. With the exception of the 4 000 basepair S1 gene, full-sized copies of all the genome segments were obtained.

Hybridisation of the different clones to dsRNA from 24 different BTV serotypes indicated that genome segments S1, S3, S4, S5, S8 and S10 were the most highly conserved. Of these S5, which codes for non-structural protein NS1, gave the best hybridisation signal with all the dsRNA isolates. This gene would therefore be an excellent group specific probe.

The most variant genes were found to be the S2 and S6 genes which code respectively for outer capsid polypeptides P2 and P5. Hybridisation of the S2 gene with dsRNA from other serotypes accurately reflected the level of cross-neutralisation between these serotypes. Genome segment S7 which codes for the major group-specific antigen P7 was found to be much more variant than expected.

The most sensitive probes were found to be the SP6 derived RNA probes. An RNA probe of BTV S7 was hybridised under different stringencies to dsRNA from different orbiviruses. The results confirmed a relatedness to cognate genes of members of the epizootic haemorrhagic disease virus serogroup.

The genes coding for the neutralisation-specific antigens of BTV10 and BTV10 have been cloned. Sequence analysis of the terminal ends of the BTV10 S2 gene indicated about 90 % homology to the S2 gene of a BTV isolate from the USA.

AGRICULTURAL RESOURCE UTILISATION

RESOURCE RESEARCH

Primary resources

SOIL

• *Soil science*

GB.5111/32/3/8: THE CHEMICAL NATURE OF SOIL ACIDIFICATION. 1982-1986
A.J. van der Merwe

It is estimated that 15-25 % of the ploughable land of South Africa is too acid for normal production of crops and at present 1,5 million tons of lime is annually applied just to counteract the acidification effect brought about by nitrogen fertilisers applied. The erratic results obtained with the implementation of measures to counteract acidification (*inter alia* liming) pointed to the fact that the nature of the problem is not yet fully understood and warranted further investigation. It was therefore decided to study the following aspects:

(i) Quality control of agriculture liming materials as been marketed.
(ii) The unfulness of present regulatory requirements to evaluate liming materials for their ability to neutralise soil.
(iii) The relative acidification effect of C and N during oxidation.
(iv) The relative replaceability of cations by H^+, K^+, Ca^{++} and Al^{+++} in soils.

It was found from sieve and chemical analysis of 80 commercially available samples including dolomites, calcites and by-products from the steel and paper industries, only 34 conformed to at least one of the current Government registration requirements (fineness and chemical purity). Neutralising performance of these samples was investigated according to several methods. Results indicated that the current registration requirements do not provide for indices that reflect the neutralisation of acid soil in the short term. Correlation studies verified that the extent of acid soil neutralisation by a particular product during a three-month period of incubation, is not related to the calcium carbonate equivalent value (CCE) as determined by total chemical analysis or acid-neutralising power.

Furthermore it was found that liming materials have to be very fine for effective neutralisation; about 50 % of the product should be finer than 250 μm and 40 % finer than 150 μm. A rather simple but reliable suspension method was developed and is now recommended for use as an additional method for the evaluation of liming materials. This method compares the relative effectiveness of a lime to neutralise a soil-water suspension of resin-acetic acid suspension to that of pure $CaCO_3$ after 24 h equilibration. These suspension method values show superior correlation with incubation values for all types of agricultural lime in contrast to any of the methods currently in use.

With respect to the replaceability of cations it was found that adsorbed Al^{3+} on the clay complex was dependent on the H^+ concentration as well as the presence of highly soluble Al^{3+}. It can therefore not be assumed that extractable Al^{3+} with KCl is always from adsorbed positions on the clay complex.

As a result of a lack of funds and the long-term nature of oxidation experiments where the acidification effect of C and N can be studied it was impossible to complete this part of the research.

SOIL

• *Soil science*

GB.5111/32/7/1: A MORPHOGENETIC STUDY OF A RANGE OF SOILS SELECTED IN NATAL AND THE EASTERN TRANSVAAL HIGHVELD. 1985-1987
K. Snyman

The greater part of laboratory research on soil genesis in South Africa has depended upon

mineralogical, chemical and physical measurements. Despite various micromorphological techniques having been successfully used abroad in soil genesis research, the use of these methods has been neglected in this country. The aim of this research was to include a micromorphological approach (studying soil thin sections with the polarising light microscope) to study soil genesis in a number of important soil types. Fourteen important agricultural soils of the eastern seaboard and summer rain cropping areas were used, *viz.* Glenrosa, Oakleaf, Swartland, Valsrivier, Estcourt, Kroonstad, Hutton, Kranskop, Shortlands and Avalon. Supporting analytical, physical and mineralogical measurements were also undertaken to complement micromorphological observations. (See end of text for explanation of the micromorphological terminology used below).

Illuvial argillans on ped faces and void walls in pedocutanic, prismacutanic and gleycutanic horizons have formed from clay illuviation. Neocutanic horizons had fewer, and sometimes lacked illuvial argillans. Argillans in the lithocutanic horizon have resulted from *in situ* mineral grain weathering. Anisotropic fabric (sepic) was identified in the cutanic horizons. Fabric in the E horizons was mostly isotropic (isotic). Removal of clay-sized material by eluvation has formed vughy microstructures in E horizons.

Sesquioxides cause random flocculation of particles with respect to each other, thereby reducing fabric anisotropy. Apedal horizons had isotic fabrics and did not have argillans. Sepic, undulic and inundulic fabrics were identified in red structured horizons. Illuvial argillans occurred adjacent to void walls in some red structured horizons.

Indurated and continuously cemented plinthite had nodules (undifferentiated fabric) and concretions (concentric fabric). Soft nodular plinthite contained isolated, round and contorted nodules. Vesicular plinthite had large horizontal pedotubules infilled with yellowish anisotropic material. The indurated nodular and concretionary plinthite is thought to have formed under conditions of a fluctuating water table while the morphology and micromorphology of the other two plinthic horizons is not consistent with this hypothesis. Soil termite influence is considered as a possible cause of soft nodular and vesicular plinthite morphology.

Assessment of soil development across a chronosequence of alluvial river terraces indicated that macroscopically structureless horizons in younger soils develop into horizons with well formed peds in the older soils. Simple packing voids decreased and compound packing voids, vughs, argillans and fabric anisotrophy increased with soil development. Linear shrinkage in the older soils was responsible for ped development and anisotropic fabric.

This study has proved that micromorphology is important in soil genesis research and provides additional classification criteria for diagnostic horizons.

Micromorphological terminology:

argillans	clay cutans
compound packing voids	random packing of individual peds
concretions	indurated, hard bodies with concentric fabric
inundulic fabric	fabric practically isotropic at low magnifications; small indistinct domains present
isotic fabric	isotropic fabric; indeterminate even at highest magnification
nodules	indurated, hard bodies with undifferentiated fabric
pedotubules	tubular bodies, often infilled with soil material
sepic fabric	shows well defined anisoptropic zones
simple packing voids	random packing of mineral grains
undulic fabric	fabric practically isotropic at low magnifications
vughs	discrete, large, spherical voids, other than packing voids
vughy microstructure	no separated aggregates; mass broken up by cattered but not interconnected vughs

SOIL

- *Soil science*

H.5111/32/1/1: THE INFLUENCE OF LIMING AND PHOSPHATE APPLICATION ON THE ACID PROPERTIES OF THREE SOILS UNDER MAIZE (*ZEA MAYS* L.). 1979-1986

D.J. Beukes

The purpose of the research reported in this study was to generate research data on soil acidity and the

effect of liming and phosphate application on maize nutrition and yield for three soils representative of the acid soils of the Highveld Region. Analyses of the data were employed to gain insight into the properties of these acid soils and give direction as to which criterion should be used to predict the need for liming acid soils for maize production in the Highveld Region. The soils used in the study were a Clovelly Mossdale, a Hutton Msinga and a Hutton Clansthal from the Heidelberg, Randfontein and Klerksdorp magisterial districts, respectively. The study was conducted in three phases, *viz*:

(a) An incubation trial conducted in the laboratory using the Mossdale soil. Applications of $CaCO_3$, dolomitic and calcitic lime and diammoniumphosphate at various levels were made to the soil and incubation at 30 °C and field moisture capacity was conducted for four months.

(b) A glasshouse trial conducted on the Mossdale, Msinga and Clansthal soils. Applications of $Ca(OH)_2$ were combined with applications of P using maize as indicator crop. The maize plants were grown in the pots for 30 days.

(c) Field trials conducted on the Mossdale, Msinga and Clansthal soils. Applications of dolomitic and calcitic lime (the same as used in the incubation trial) were combined with applications of P using maize as indicator crop.

The field trials were conducted from the 1979/80 to the 1982/83 seasons. Analyses of soil properties, leaf composition and maize yield were done and the following conclusions were drawn:

- Lime applications on all three soils caused significant changes in pH (H_2O and KCl), exchangeable Ca and Mg, effective CEC, exchangeable Al, acidity and Mn and also percentage Al and acid saturation of top soil samples.
- Maximum effects of lime in the field trials were encountered three years after application.
- Liming of the plough layer retarded sub-soil acidification.
- Exchangeable Ca and Mg increased and Al and acidity decreased with increased lime applications in sub-soil layers of the Mossdale and Msinga soils three years after lime application.
- Liming increased Ca and Mg content and decreased Al, Mn, Zn and Fe content of maize leaves.
- Liming trials conducted under glasshouse conditions led to findings that were not substantiated under field conditions.
- Highest yield under field conditions did not necessarily imply maximum economic return.
- Phosphorus "build-up" of the soil was found to be uneconomical.
- Liming of acid soils is economically justifiable under the widely varying weather conditions experienced in the field trials.
- Overliming effects found in the glasshouse trial at applications exceeding 2 tons lime/ha were not found under field conditions, probably because of low lime reactivity, acid sub-soils and re-acidification of limed soils.
- Average annual rainfall, the fraction of lime passing a 0,25 mm sieve and CCE determined by incubation (or a more rapid method other than the 0,5 N HCl method) should be taken into consideration when determining lime requirement for acid soils.
- The 25 % acid saturation criterion for lime requirement used in Natal or alternatively the 12 % Al saturation criterion (Fox, 1979) was found to be the most suitable of the criteria tested for identifying lime requirement for economical maize production.
- Dolomitic lime should be used when the exchangeable Mg of the topsoil is below 0,3 me per 100 g soil and when sub-soil Mg is below 0,2 me/100 g soil.
- Leaf analysis done in the preceding season should prove valuable for determining whether dolomitic or calcitic lime should be used.

SOIL

- *Soil science*

W.5111/32/2/2: SOIL: THE EFFECT OF POTASSIUM FERTILISING LEVELS ON THE GROWTH AND YIELD OF WHEAT IN THE WINTER RAINFALL REGION. 1977-1986

C.P. de L. Beyers

Dominant soils of the wheat producing areas in the Winter Rainfall Region have developed on Malmesbury phyllites and Bokkeveld shales and rarely contain less than 50 mg kg^{-1} of K. Soils derived from

an inland range of Table Mountain sandstone and outcrops of granite usually have K contents of less than 50 mg kg^{-1}.

About 33 % of more than 30 000 topsoil samples indicate a K content (citric acid) of less than 50 mg kg^{-1} which is considered a critical level in respect of dryland wheat.

In order to study the response of dryland wheat to K supplementation, rates of 0, 20, 40, 60 and 80 kg of K were combined with three levels of N in factorial experimental designs on five different soils. Other nutrients were optimised in the soil.

Soil analysis were carried out on samples taken after harvesting operations and findings on composition and yield were related to K levels in the soils rather than rates of K applications.

Increasing rates of K fertilisation on an Estcourt (33) soil increased yield of straw and grain at up to 36 mg kg^{-1} K in the soil.

On a Wasbank (21) and an Estcourt (34) soil containing 41 and 45 mg kg^{-1} K, respectively, K fertiliser had no effect on yield.

Under conditions of severe moisture stress on a Pinedene (14) soil with 22 mg kg^{-1} K, increasing levels of soil K had no effect on yield, but resulted in significant increases of K uptake by wheat plants.

In the case of the Wasbank (21) and Estcourt (33) soils, increases in mass of young plants were recorded at soil K contents of up to 57 and 48 mg kg^{-1}, respectively, although no effects on yield were recorded.

On a Glenrosa (16) soil with 185 mg kg^{-1} K, increasing rates of K fertiliser had no effect on yield or plant composition.

Responses in the yield of wheat were recorded only at soil K levels of lower than 40 mg kg^{-1}. Plant uptake of K however, showed increases of up to approximately 60 mg kg^{-1}.

No interaction between N and K on yield were found in any of the five experiments.

Potassium fertiliser had a marked effect on Ca and Mg uptake, Ranging from positive to negative at four of the experimental sites.

SOIL

- *Modelling*

V.5111/42/1/1: MODELLING OF FERTILISER REQUIREMENTS OF CROPS UNDER IRRIGATION AND ON DRYLAND IN THE FREE STATE REGION. 1979-1982

G.N. Krynauw

Providing a reliable fertiliser advisory service to the primary producer has become a necessity for sound farming practice. The modern computer is an obvious expedient to handle such a task and the application of computer programmes for fertiliser advisory purposes has become an established practice with many advantages.

The present study was undertaken to develop a computer programme which is adapted to the conditions and requirements of the Free State Region. The model which was used as a starting-point, was the existing procedure used by the Chemistry Section of the Free State Region to interpret soil analysis and make fertiliser recommendations.

The computer was programmed to give a printout of the following:

- a table reporting the complete analysis of each soil,
- for each soil
  - the applicable corrective measures in regard to brack, soil reaction, phosphorus and zinc status and
  - the fertiliser requirements for the production of crops as requested

The input data for the computer were supplied on a coding form and included soil analytical data and code(s) for the relevant crop(s) only. All interpretations of the analytical data and for the fertiliser requirements were handled by the programme.

Fertiliser recommendations for twelve cash crops, fourteen forage crops, nineteen vegetable crops, deciduous fruit trees, table grapevines, vineyard and lawns were inserted in the computer programme for yield targets that are realistic for the conditions in the Free State Region.

From a survey that was conducted on two study groups in the Vaalharts irrigation area, it would seem that persons lack self-confidence to interpret a soil analysis report on their own. However, the problem lies with the interpretation of the data as such and is not related to the computerised form of presentation.

A comparison was made between the former procedure of advisory service by letter and the computerised service with respect to time and costs involved. It was found that the computerised system resulted in a saving of 77 % in time and 65 % in costs.

The study has resulted in the successful computerisation of the fertiliser advisory service of the Free State Region. The computer programme meets the present requirements. Modification will be required, where applicable, with respect to newly established critical test values and revised fertiliser requirements of crops.

Expansion of the model to take into account the bioclimate, soil profile characteristics and management aspects will necessarily have to be considered when accurate data in these fields become available.

CLIMATE

- *Water requirements*

GB.5113/31/1/1: ESTIMATION OF THE SPATIAL DISTRIBUTION OF PAN EVAPORATION OVER SOUTH AFRICA. 1981-1986

B. Clemence

The aim of this study was to find a means of estimating Class A pan evaporation over Southern Africa which would be sufficiently accurate for detailed irrigation planning purposes anywhere in the sub-continent.

The first stage in the project was to determine the best readily available variables which could be used in the development of regression equations to estimate evaporation. Mean air temperature is commonly used in temperature-based equations to estimate evaporation. However, maximum daily temperature was postulated to relate more closely to evaporation, since water loss to the atmosphere is largely a daytime process. Daily evaporation and air temperature data were therefore used to create a data file of bimonthly mean daily values from approximately 130 long-term weather stations in Southern Africa. Bimonthly mean evaporation data, and to a lesser extent temperature, were found to be less scattered than daily values and hence more reliable.

Although air temperatures relates closely to the evaporation rate, the effects of other less widely available weather elements such as air humidity and wind speed should still be accounted for. The influence of wind speed and humidity varies markedly from location to location. To allow for this in a temperature-based evaporation-estimation equation, a regionalisation of weather stations to be used in model development in this study was necessary. The regionalisation was based on latitude, altitude, seasonal rainfall distribution and continentality.

Within each of the evaporation regions, a series of temperature-based evaporation-estimation equations was developed using regression analysis. This entailed optimising various physiographic and meteorological factors associated with the evaporation process. The most successful expression in each of the regions proved to be that incorporating altitude, together with maximum air temperature modified by a daylength factor. It was found that the Winter Rainfall Region was the only case where it was better to use 2 "seasonal" equations to estimate evaporation rather than a single equation for the whole year.

The evaporation regions were then used as a basis for the development of equations which evaluated mean maximum daily air temperature, a primary input in the evaporation formulae. This was essential for mapping purposes. Temperature and thereafter evaporation were estimated at each co-ordinate of a 5 minute by 5 minute of a degree conceptual grid (which contained, *inter alia*, altitude data at each grid point) laid over Southern Africa.

This study shows that the estimation of Class A pan evaporation in places where it is not measured is feasable, provided estimates are made over a minimum period of about 2 weeks. There are certain parts of the country where the equations should be used with care, especially in areas where wind speed and humidity levels vary a good deal between the seasons (e.g. Region 6). Other areas which presented problems in the development of the regression equations were Lesotho and the West Coast, where long-term records of simultaneous evaporation and air temperature data were scarce. No doubt, future research will concentrate on improving this situation once more data become available.

• *Meteorology*

GB.5113/33/1/4: CLIMATE: THE DETERMINATION AND CLASSIFICATION OF THE WATER SUPPLY POTENTIAL OF NATURAL RAINFALL. 1978-1986

A.L. du Pisani

This research was directed at the question of which part of the natural rainfall is ultimately used by the growing plant. To do this a simple soil moisture budget model was used which operated on a daily basis and used either maximum temperature or Class A pan evaporation to calculate potential evapotranspiration and used daily rainfall as its credit side. The model was first developed for winter wheat and adapted later for maize and *Themeda triandra* grass. Parameters which could be calculated were potential and actual evapotranspiration, effective rainfall, soil moisture content and moisture stress days. This last parameter was taken as the number of days when all the available soil moisture had been withdrawn by the plant. The model can be used for single or multi-year runs, the latter calculates water use in the off-season so as to calculate carry-over of moisture from the one season to the next.

The most work was done on the application of the model with the maize crop. Using yield data collected at Potchefstroom a method for calculating yield was developed. The first step was to calculate potential yield (PY) using the total potential evapotranspiration (TPET) for the growing season.

$$PY = \frac{TPET}{424,4} \times 4575 \text{ kg/ha}$$

Actual yield (AY) was calculated using the number of moisture stress days (MSD) accumulated 70 to 100 days after planting.

$$AY = PY \times 0,88^{MSD}$$

This methodology was applied to determine suitable planting dates using climatic data, to ascertain the importance of rainfall oscillations in agricultural planning and to assess drought risk for dryland maize production. This model has also been used in the ACRU-model developed by the University of Natal.

The soil moisture budget for natural pasture was used to obtain a climatology for soil moisture so that drought could be assessed in terms of the probability of the current soil moisture status in terms of the normal soil moisture content.

It has been shown that the Ceres-maize model developed by Ritchie in the USA could be used to assess drought in the RSA by making use of the so-called median year data to run out the model in order to calculate expected yield at a relatively early stage of the growing season.

• *Meteorology*

GB.5113/33/1/10: DELINEATION OF HOMOGENEOUS CLIMATIC AREAS FOR MAIZE PRODUCTION IN THE SUMMER RAIN CROPPING AREAS. 1983-1984

J. Myburgh and F.G.L. Koch

To facilitate the recommendations regarding which maize cultivar to plant, cluster analysis techniques were used to devide the maize production areas of the summer rainfall region in homogeneous climatic regions. Climatic parameters which are considered to have an important influence on maize production were used to do the classification. These parameters are the mean rainfall during the six 10-day periods from 17 December to 14 February, the mean date of the first planting rains of the season, the mean minimum temperatures during September, October and March and the mean maximum temperatures during October, November, January and February. The first planting date was taken as the first date on which 20 mm of rain has fallen within 5 days.

The values of the climatic parameters were calculated at points on a 0,5 degree latitude by 0,5 degree longitude square grid of the region. The rainfall means and the first planting dates at a point were calculated

the means at all the rainfall stations within a 0,5 degree by 0,5 degree square surrounding that point. The ean temperatures were calculated from the longitude, latitude and altitude at the points with regression lationships established previously.

With the classification strategy used it was possible to take a prior or preferred grouping of the points to account. Different classifications, based on the groupings by several organisations, were performed. The gnificance of the differences between the group means of the parameters was used as criterion to select the est" classification. The best classification is presented as a map of the region.

Surveys and demarcation

FAIRLY HOMOGENEOUS AGRICULTURAL AREAS

Ecology

.5134/27/1/1: RHFA: A PLANT ECOLOGICAL STUDY IN THE KAROO AND ARID REGIONS OF THE KAROO REGION IN TERMS OF LAND TYPES. 1983-1985

M. Vorster

Nature and scope

The facet comprised of classifying the 291 preliminary land types of the Karoo Region (approximately 29,06 million ha) into reasonably homogeneous farming areas (RHFAs) by means of vegetation and environmental factors, as well as to explain the interaction between the different elements of the land types.

Specific findings

The 291 preliminary land types in the Karoo Region were classified into 144 reasonably homogeneous farming areas (RHFAs). The land types were firstly reduced to 23 floristic climatic regions (FCRs) according to character species for certain macro-climatic conditions. The character species were identified by means of computer classification and ordination techniques (PHYTOTAB, TWINSPAN and DECORANA).

About 22 soil forms and numerous soil series were found in the Karoo Region. Based on differences in the inherent veld production potential and erodibility of the different soils, as well as differences in slope, nine Veld Soil Potential Classes (VSPCs) were synthesised. The land types in each of the FCRs were, lastly, consolidated according to their similarity in terms of macro-climate and dominant topographical units and VSPCs, into RHFAs. For each of the RHFs' norms with respect to present long-term grazing capacity, stock breeds, veld management and veld burning principles, were proposed.

FAIRLY HOMOGENEOUS AGRICULTURAL AREAS

• *Potential studies*

H.5134/36/1/4: THE DESCRIPTION OF PRODUCTION POSSIBILITIES OF NATURAL RESOURCES PER MAGISTERIAL DISTRICT ACCORDING TO RHFs SUB-DIVISIONS WITHIN THE SUMMER RAIN CROPPING AREA OF THE HIGHVELD REGION. 1983-1987

J.J. Scheepers

The agricultural potential of the different magisterial districts in the Highveld Region is described in terms of dryland, agronomic and livestock production. The Region comprises 48 magisterial districts that are divided into 57 reasonably homogeneous farming areas with the aid of land-type information. Expected long-term yields for maize, grain sorghum, sunflower, wheat, dry beans, groundnuts and potatoes were calculated according to an optimum crop pattern for reasonably homogeneous farming areas on a magisterial district basis with the aid of recognised yield formulas. The livestock production potential was calculated

according to the stocking rate potential for reasonably homogeneous farming areas, on magisterial district basis, in terms of large stock units.

A summary of the available natural resources with proposed optimum crop patterns and expected long-term yields of areas suitable for crop production on magisterial district basis, serves as a very valuable aid for all institutions concerned with the planning of optimum resource use in agriculture. The following serve as possible fields for the use of these data for short, medium and long-term planning:

- Determining the production potential of magisterial districts.
- The identification of productive agricultural land per magisterial districts - land that should be used for agricultural purposes.
- To determine the production potential of alternative branches of farming in magisterial districts.
- The identification of production areas in magisterial districts for specific crops.
- Making crop choices in magisterial districts so that the best possible use can be made of specific resource situations.
- The allocation of available funds, aids and manpower to stimulate optimum agricultural development.
- The placing of grain silo's in magisterial districts.
- Determining norms for yield-related market prices for agricultural land in magisterial districts.
- The determining of yield norms for resource units at farm level in magisterial districts.
- Determining norms for the enforcement of certain agricultural acts, such as the Sub-division of Agricultural Land Act, in magisterial districts.
- The planning of roads, towns and cities in such a way that good agricultural land in magisterial districts is not lost.

LAND USE

- *Situation analysis*

T.5135/35/1/1: LAND USE: RECONNAISSANCE SURVEY FOR THE SILVERTON EXTENSION WARD. 1978-1983

J.B. Stevens

The Silverton Extension Ward consists of 13 magisterial districts in the Pretoria and the Witwatersrand area. It is an intensive mixed farming area with a heterogeneous community with many small-holdings and part-time farmers. This is a heterogeneous area and virtually all the farming enterprises occur. The survey was done to gather general information on the Extension Ward for the launching of extension programmes.

A short questionnaire was posted to 1 850 farmers and 36 % were returned. The survey showed that seven main enterprises namely vegetables, beef, field crops, poultry, deciduous fruit, pigs and dairy cattle are the main contributors to the gross income. The main vegetables grown are tomatoes, potatoes, cabbage, green beans, peas, carrots, beetroot, onions and pumpkins. While maize, wheat, sunflower and dry beans are the most important field crops; peaches, apricots and strawberries are the main fruit crops with lucerne, *Eragrostis curvula* and kikuyu the main forage crops. The survey indicates that the veld is not in general overgrazed by large or small stock.

Approximately 22 % of the farmers had post-school agricultural training. Only 13 % of the farms were planned. There are three District Agricultural Unions and 16 Farmer's Associations in the Extension Ward.

The resources of the Extension Ward were illustrated on four maps.

The conclusions can be summarised as follows:

- The survey was successful in obtaining a quick general picture of the area;
- every effort should be made to recover as many questionnaires as possible in future projects;
- the production of fruit, vegetables, field crops, dairy farming and the breeding of sheep are generally on a low level and can be greatly improved;
- farmers regard labour as their main problem, while high production costs and marketing, were second and climatic factors third in order of priority;
- extension action should rather be concentrated on separate farming enterprises instead of on the whole ward or community;
- the use of available agriculture land within municipal areas should be investigated;
- special attention should be given to the deciduous fruit growers and the extension needs and priorities of the part-time fruit growers.

RESOURCE UTILISATION RESEARCH (CROPS)

Summer grain

MAIZE

• *Physiology*

N.5211/03/1/1: THE DIFFERENTIAL TOLERANCE OF CULTIVARS OF MAIZE (*ZEA MAYS* L.) TO ALUMINIUM (Al) TOXICITY IN THE HIGH RAINFALL SOURVELD AREA. 1982-1986

R.J. Bennet

Extensive studies, which involved light and electron microscopy, showed that the response of maize roots (cultivars TX 24 and HL1) to Al was directed through the disruption of intercellular co-ordination existing between the cell populations comprising the root meristem.

The first detectable response to Al in the root involved disruption of Golgi apparatus function in the cap periphery. Ultrastructural changes in the cap periphery coincided with the presence of Al in these cells. Conspicuous physiological changes involving cell enlargement, cell metabolism and root elongation were identified in cells initially remote from the site(s) of Al uptake. Communications between the Al-damaged peripheral root cap cells and the cell populations of the cap and proximal meristems, quiescent centre and region of cell growth was therefore indicated. A decrease in amyloplast numbers present in the root cap in response to increasing Al concentration coincided with diminished Golgi apparatus activity in the peripheral cap. These changes preceded detectable reductions in mitotic activity, indicated by decreases in cap volume and root length, and it was consequently suggested that control of intercellular activities in the root meristem may be directed through polysaccharide metabolism.

Low concentrations of Al ($< 1{,}25$ mg dm^{-3}) produced a positive growth response in the primary root. This coincided with an increase in mean cap volume and these events were interpreted as an Al-induced release of the proximal meristem from growth inhibition originating in the cap. Experiments which followed the effect of decapping on the morphology of quiescent centre cells in the presence or absence of Al supported the existence of a Golgi apparatus-derived morphogen involved in the control of Golgi apparatus secretory activity and plastid differentiation. In contrast to the controls (O ABA), treatment of decapped roots with 2×10^{-4} and 5×10^{-2} M abscisic acid inhibited the development of Golgi apparatus secretory activity and plastid differentiation. It is postulated therefore, that an early response to Al may involve inhibition of the basipetal movement of an endogenous growth inhibitor originating in the cap, which may be ABA.

The presence of Al in the nutrient solution caused an efflux of H^+ from the root. Some of the more adverse responses to Al were initiated at Al concentrations where the molar ratio of charge between Ca^2 and Al^{3+} favoured Al. A hypothesis for an electrophysiological plant response to Al involving membrane hyperpolarisation by Al ions is developed.

Chemical analysis of plant fractions did not connect Al-induced nutrient disorders with the primary expression of Al toxicity.

A role for Al in disrupting the co-ordination of intercellular activities in the root meristem has not previously been considered. Conclusions arising from this investigation are therefore combined with an analysis of events involved in stress physiology to reflect on possible mechanisms of Al tolerance.

Small grain

WHEAT

• *Pathology*

SMALL GRAIN: GEOGRAPHIC DISTRIBUTION OF (*FUSARIUM* SPP. ASSOCIATED WITH CROWN ROT IN DRYLAND WHEAT IN THE FREE STATE REGION. 1985-1986

O. Los

Many different *Fusarium* species are found in the cultivated soils of the Orange Free State. Some of

these species are common to the whole area surveyed, for example *F. oxysporum* and *F. solani*. Other species are restricted to a specific area. *Fusarium crookwellense* is restricted to the eastern parts of the Free State, *F. compactum* to soils in the central and western parts of the Free State, while *F. nygamai* is common in soils of the southern parts of the Free State.

There was a considerable variation in the total number of each species isolated. Species such as *F. equiseti* and *F. oxysporum were isolated in high numbers, while other species such as F. merismoides* and *F. dlamini* were represented by one isolate each.

Various *Fusarium* species are associated with crown rot of wheat. Similar to the phenomenon of certain species in soils being restricted to certain areas, some of the pathogens isolated from infected plants were restricted to specific areas. Thus *Fusarium crookwellense, F. culmorum* and *F. longipes* were isolated in specific areas from infected wheat plants. Species such as *F. equiseti, F. graminearum* and *F. oxysporum* were isolated frequently from infected plants collected over the whole area surveyed.

The occurrence of *Fusarium* species in the seed of different wheat cultivars was investigated over a period of three years on seed from two production areas. The occurrence of the *Fusarium* species differed from season to season. These differences could not be ascribed to climatic differences between the three wheat seasons. The differences which occurred were the same for each cultivar for each production area. The species, isolated from seed produced in the two areas did, however, differ. A greater variety of species was isolated from seed produced in the Bethlehem area than from seed produced in the Bloemfontein area. Species isolated from seed, represented species isolated from the soils of the two areas. Thus *F. compactum* and *F. equiseti* were the two species most frequently isolated from seed produced in the Bloemfontein area. These two species were also the most common species isolated from soils in this area. Species associated with crown rot of wheat, i.e. *F. culmorum* and *F. graminearum*, were seldomly isolated from seed. They were isolated only from seed produced in the Bethlehem area. *Fusarium crookwellense*, recently shown to be a pathogen of wheat, was isolated from the seed produced at Bethlehem at a very low frequency.

This survey shows that various *Fusarium* species play a role in causing crown rot of wheat. The relative importance of each species depends on the specific area, the availability of water and the cultivar planted.

Other agronomy crops

SUNDRY AGRONOMY CROPS

- *Nutrition*

OTHER FIELD CROPS: NPK NUTRITION OF CHICORY AT BATHURST. 1981-1984

R.S. Marr

This trial was conducted at Bathurst. First- and second-year chicory yields were fairly good and third and fourth year yields very poor, in spite of reasonably good rainfall distribution in the fourth year. Fertiliser effects on yields were relatively unimpressive. In the first harvest of second year 60 kg N resulted in better chicory yields than 0 and 120 kg N (all rates per hectare), whereas 0; 60 and 120 kg P gave linear yield increases. The 120 kg N was associated with marked yield reductions in the fourth harvest of the second year. However, when only plots receiving balanced fertilisers are considered, strongly positive and economic effects are noticed. There are indications that N might promote and K might retard yield of branched roots.

Considering leaf analysis it is noteworthy that experimental treatments (N, P and K) seldom affected markedly the analysis for the respective element. Also, the fact that leaf analysis were not related to yields implied that all the contents measured were within the sufficiency range (as opposed to deficiency or toxicity). This meant that threshold values for deficiency and toxicity could not be established on the basis of these results.

Soil analysis increased by 1 pmm for each 3,6 to 4,3 kg K applied per ha and for each 0,6 to 13,8 kg P applied per ha. As with leaf analysis, soil analysis were not strongly associated with yields, probably because the levels in the soil were high enough to promote growth in the absence of fertiliser (P values mainly > 60 and K values mainly > 150 ppm).

• *Crop science*

OTHER FIELD CROPS: CHEMICAL CONTROL OF WEEDS IN CHICORY. 1973-1987

J.D. Aucamp

Chicory, a slow growing crop in the early stage, is also Compositae and difficult to distinguish from closely related weeds. Hand weeding and hoeiing, apart from reducing the stand of chicory, is also not possible when wet weather intervenes. Initial screening trials were used to test over 50 compounds for phytotoxicity to crop and weeds (1974, 1976 and 1979) followed by preliminary trials on a range of soil types in 1975, 1976, 1977 and 1978. In the later preliminary trials the European Weed Research Council (EWRC) method of scoring phytotoxicity and efficacy was used. More detailed studies rounded off the investigations.

From the results of this facet no single product or mixture of products is sufficiently harmless to the chicory and toxic to the main weed spectrum; for this reason no product or mixture of products can safely be adopted for general use in chicory production in the chicory producing areas of the Eastern Cape Region.

• *Crop science*

OTHER FIELD CROPS: EVALUATION OF CHICORY CULTIVARS. 1971-1983

J.D. Aucamp

Thirty-two imported cultivars and thirteen locally produced progenies were tested over a period of 12 years and at fifteen different sites. The five currently commercially available cultivars (Pevele, Flandres, Luxor, Wixor and Fredonia) seldom differed significantly from each other and were seldom significantly out-yielded by other cultivars. They sometimes out-yielded other cultivars notably Novipa and Agricultural. Pevele has a problem with branched roots. There is a general superiority of research station sites over co-operative sites (yields, cultivar and significance of F tests).

The usefulness of extensive co-operative research must be carefully examined. Locally produced progenies of two cultivars (Pont de Pierre and Polonowicka, neither of which is currently available) out-yielded the parents by a considerable margin. Except for the yield at Dohne in 1975/76 (2,3 t) best yields at research station sites were all between 7,3 and 17,3 t dry root/hectare, while best yields at co-operative sites ranged from 2,4 to 8,7 t dry root/hectare.

Tuber crops

POTATOES

• *Pathology*

EPIDEMIOLOGY AND CHEMICAL CONTROL OF POTATO EARLY BLIGHT IN THE NATAL MISTBELT OF THE HIGH RAINFALL SOURVELD AREAS. 1980-1984

W.G. Nevill

Five aspects of potato early blight under Natal Mistbelt conditions were investigated over four seasons at the Cedara College of Agriculture:

(i) effect of inoculum on disease development
(ii) potato cultivars and disease development

(iii) effect of fertilisation on disease development
(iv) effect of dew on disease development, and
(iv) chemical control of the disease.

Inoculum in the form of pulverised leaf and stem debris from the previous season's diseased potato crop stored for six months in a deep freeze at -34 °C, caused far more severe disease symptoms than inoculum stored under cover or left on or under the soil surface during winter. Inoculum left on or under the soil surface during winter was not as effective in inducing disease as the dry-stored inoculum, probably owing to deterioration of the organic material as a result of winter rains. The application of inoculum in the form of dry leaf and stem debris as a mulch on the potato rows immediately after planting was highly successful as initial infection took place as the potato plants grew through the debris. Natural infection was the easiest way of "inoculating" potato plants under conditions of the experiments at Cedara during the four seasons.

The season (1982/83) in which the cultivars BP1, Cedara, Kimberley Choice, Pimpernel, Sackfiller, Up-to-date and Vanderplank were compared in three experiments was very dry and tuber yields very low. Sackfiller, Kimberley Choice, Cedara and Pimpernel, in that order, had the most tolerance to early blight in the foliage.

Late maturing Sackfiller was the most tolerant cultivar in all the experiments in which it was planted during the four seasons, while early maturing Vanderplank was the least tolerant and because of the early maturity it is suggested that it is not the most useful cultivar to be used in fungicide experiments. The popular medium maturing cultivars BP1 and Up-to-Date were equally susceptible to early blight and because of their longer growing season, and therefore longer exposure to early blight in the field, should be cultivars of choice in inoculum and fungicide experiments.

Higher applications of nitrogen (200 kg/ha) tended to increase tuber yields and significantly reduced the rate of foliage destruction compared with the 0 and 100 kg/ha levels. Heavy applications (50 and 100 kg/ha) of phosphorus (P) significantly increased yields compared with the PO treatment but the rate of foliage destruction was significantly increased by the higher rates of P.

Potassium (K) had no significant effect on either yield or foliage destruction, although the highest rate tended to increase yield and reduce the rate of foliage destruction.

Two experiments specifically examined the effect of dew on potato early blight.

Potato plants covered by tunnel plastic did not receive as much rainfall as the exposed plots and thus did suffer some moisture stress. There were no significant differences in tuber yield between covered and exposed plots but the progress of the disease was significantly delayed under the tunnel plastic. Shade cloth (30 %) had no significant effect on the rate of foliage destruction by early blight compared with plants grown in the open.

Twenty-one fungicides were used in the 23 experiments conducted over the four seasons. Topthane and Bravo were, overall, the most effective registered fungicides against early blight which is always severe under Cedara conditions. Topthane had no apparent phytotoxic effect on potatoes under the conditions of these experiments. Significant reductions in the rate of foliage destruction by early blight resulted in significant increases in tuber yields in 16 of 19 experiments in which the best fungicide treatment was compared with Ridomil or "no fungicide" treatments.

Cost comparisons between fungicide treatments/programmes were not made because of regular price fluctuations and different marketing strategies in the crop protection market.

RESOURCE UTILISATION RESEARCH (ANIMALS)

Ruminants

LARGE STOCK

• *Reproduction*

N.5311/04/1/4: REPRODUCTION IN THE BEEF FEMALE AS INFLUENCED BY BULL LIBIDO IN THE HIGH RAINFALL SOURVELD. 1984-1987

J.S. Chrichton

The relationship between beef bull libido and conception rate following a 21-day breeding period was

investigated over two seasons. Libido was defined as the number of services completed during a 10-minute exposure to a restrained oestrous female.

In the first year bulls which achieved a mean libido score of three or more services were compared with bulls which achieved a mean of one service. In the second year a mean score of six or more services was compared with a mean of three services. Bulls were joined as single sires at a bull to female ration of 1:35 in the first and 1:40 in the second year. Libido, as measured in this study, did not influence conception rate significantly.

LARGE STOCK

• *Reproduction*

V.5311/04/1/3: LARGE STOCK: THE APPLICATION OF GONADOTROPHIN RELEASING HORMONE (GnRH) DURING AI IN AFRIKANER COWS UNDER EXTENSIVE CONDITIONS AT ARMOEDSVLAKTE. 1979-1982

J.A. Vermeulen

Afrikaner and cross-bred cows were used during two successive mating seasons to evaluate the application of GnRH during AI. Cows were heat spotted and inseminated artificially 12 h later. Group 1 was injected with GnRH at oestrus, Group 2 at AI (12 h after oestrus), and Group 3 served as controls.

Time of GnRH treatment had no effect on conception. In Afrikaner cows conception was higher in GnRH treated cows than in Controls (63 *versus* 33 %) but the control cows mass-measured 16 kg less at AI. GnRH treatment had no effect on conception in cross-bred cows. The successful application of GnRH to increase conception during AI is therefore limited to Afrikaner cows.

Apart from this summary, the results will not be published because of shortcomings during the execution of the experiment.

LARGE STOCK

• *Nutrition*

H.5311/05/2/1: LARGE STOCK: PRESERVATION AND PROTEIN STABILISATION OF MAIZE SILAGE. 1978-1986

L.D. Snyman, H.J. van der Merwe, A.P. van Schalkwyk, René du Preez and Irma Calitz

In this experiment, the effect of formaldehyde preservation of maize silage was investigated with respect to: (1) chemical composition and fermentation characteristics and (2) protein protection and digestibility, of the silage. The purpose of this investigation was mainly to evaluate formaldehyde preservation as a method to ensile maize plants successfully at maturity stages containing sub-optimal moisture content.

Maize plants were ensiled at maturity stages varying in moisture content between 51 and 78 %. Plant material at each maturity stage was ensiled with formaldehyde additions varying between zero and 10 g formaldehyde per 100 g of crude protein content. These treatments were performed on plants which were grown on two different localities during two different years. Formaldehyde was applied with and without addition of formic acid (1 ℓ/ton wet material).

Results indicated that plants at a high-moisture stage were more successfully preserved with formaldehyde than without it. Contents of water-soluble carbohydrates and true-protein specifically, were markedly increased by increasing applications of formaldehyde. Fermentation activity was inhibited by formaldehyde application as was indicated by a decrease in the contents of lactic and total volatile fatty acids. This resulted into an increase of the silage pH which may lead to an increase of silage dry matter intake.

Formaldehyde preservation of material with a low moisture content also inhibited fermentation activity but exerted a conservational effect on true-protein only. It led to a decrease in the content of water soluble carbohydrates. This was probably due to an increase in respiration activity as the decrease in water-soluble carbohydrate content was accompanied by a simultaneous increase in moisture content.

The simultaneous addition of formic acid exerted little additional influence to that of formaldehyde.

In vitro ammonia release data obtained, predict an increased protection of silage protein against ruminal degradation by formaldehyde treatment. At the same time, the ration of acid detergent insoluble nitrogen to total nitrogen predicted a decrease in post-ruminal digestibility of silage proteins. The results suggest that the maximum supply of digestible by-pass protein to the small intestine may be connected to a specific optimum level of formaldehyde treatment. Amino acid analysis on the silage material indicated that formaldehyde protected bypass protein in maize silage may be unbalanced with respect to lysine and arginine.

LARGE STOCK

• *Nutrition*

N.5311/05/1/1: **LARGE STOCK: THE CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF VELD FOR BEEF CATTLE IN BIOREGIONS 3 AND 4.**

R.M. Bredon, A.D. Lyle and T.J. Dugmore

A series of cutting trials were conducted on 7 farms and the Kokstad Research Station over a period of 3 years. Herbage selection (oesophageal fistula) and grazing trials were conducted concurrently to the cutting trials on the Kokstad Research Station.

It was found that while the quality of undisturbed veld declined rapidly over the growing season, the cut veld remained consistent in quality. Quality of the herbage declined as the cutting interval was lengthened whereas dry matter yield increased with longer cutting intervals up to an 8 week interval after which it declined. Herbage selection was found to occur at significant levels at the 8 week regrowth stage and older.

The grazing trial recorded average daily gain of 0,58 kg/day over the growing season, which proved to be close to potential animal performance on the veld calculated from the results of the cutting trials.

LARGE STOCK

• *Nutrition*

N.5311/05/3/1: **CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF KIKUYU PASTURE FOR LACTATING DAIRY CATTLE IN THE HIGH RAINFALL SOURVELD AREAS AT CEDARA. 1972-1985**

R.H. Bredon, T.J. Dugmore and J.H. du Toit

The chemical composition of kikuyu indicates that it is of equivalent nutritive value to ryegrass. Ryegrass has been shown to have sufficient energy to supply maintenance plus 17 litres milk production for a 500 kg dairy cow, whereas 500 kg cows grazing kikuyu have been shown to produce 11 litres in spring, 9 litres in summer and 7 litres in the autumn.

A series of *in vivo* digestion trials conducted over the growing season were undertaken to determine why the discrepancy between kikuyu and ryegrass of similar chemical composition existed. Non-protein nitrogen (NPN) and dry matter intakes (DMI) were measured in addition to total digestible nutrients (TDN) values to determine what effect NPN had on DMI and TDN.

The TDN, NPN and CP (expressed as N, CP = N x 6,25) values for the kikuyu grazing over the growing season are illustrated in Fig. 1. It is evident that CP levels increase over the season, peaking in autumn while crude fibre levels were found to decline over the season. The TDN values for the kikuyu over the growing season have two distinct peaks, one in the spring and the other in the autumn (March).

The autumn peak in the energy (TDN) values of the kikuyu herbage does not correspond with the performance of lactating cows over the season. Grazing trials on Cedara have shown that milk production from cows grazing kikuyu declines as the season progresses.

There are three likely factors for this discrepancy between the digestibility of kikuyu and milk production from cows grazing kikuyu:

(a) Some factor in the kikuyu could be causing the intake of kikuyu in the autumn to be lower than expected when taking its energy concentration and chemical composition into account. A negative correlation was measured between NPN and dry matter intake (DMI) expressed as a percentage of body mass (BM) for the present data:

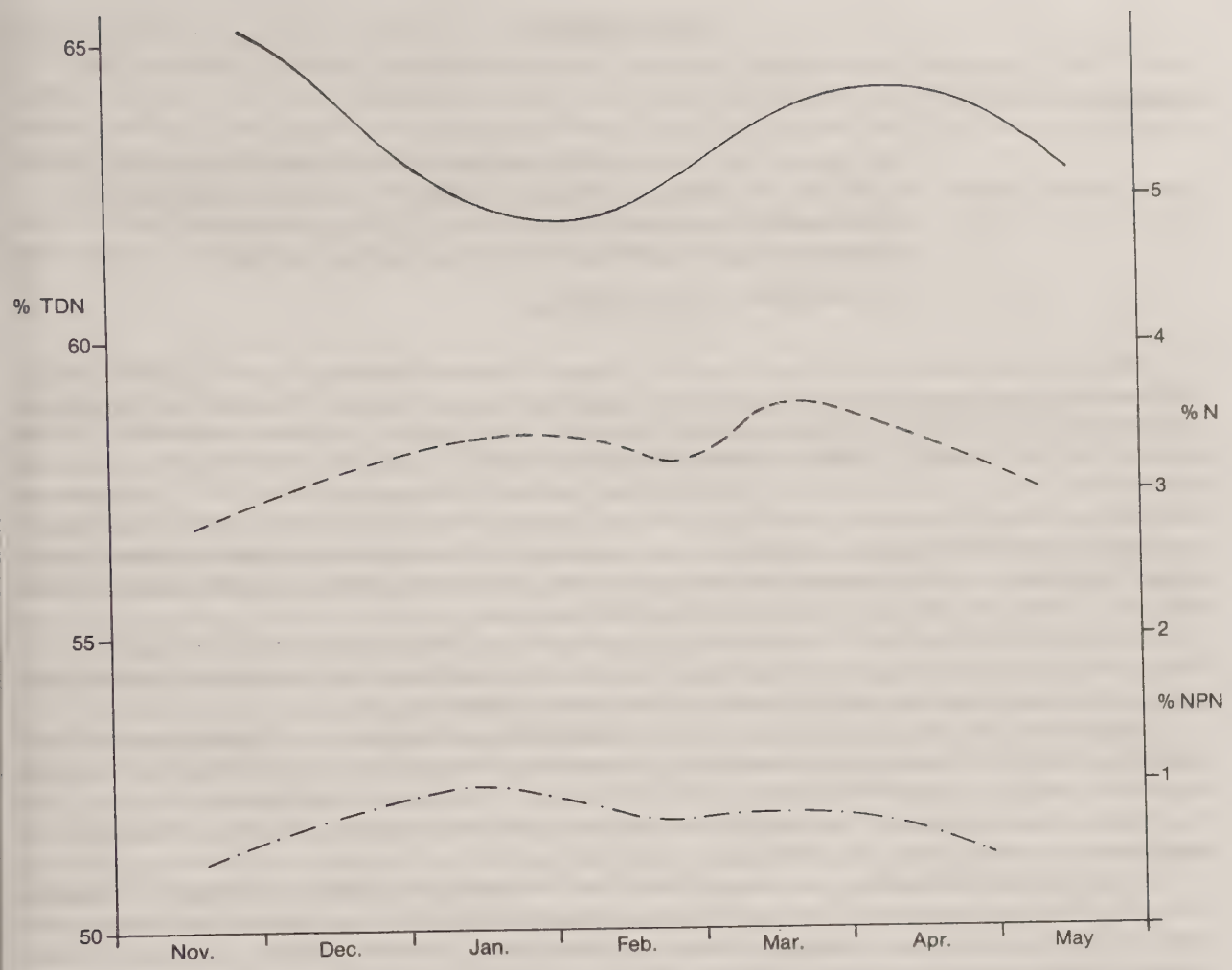

FIG. 1 - Curves representing average TDN (—), nitrogen (— — —) and NPN (—.—) levels in the kikuyu dry matter

DMI (% of BM) = 2,794 - 1,092 NPN (% DM); r = -0,781 ($p < 0,05$)

(b) The second possibility is that the large proportion of NPN in the grass may affect the calculated TDN, i.e. all the nitrogen is accepted as being digested while part of it could be lost via the urine.

(c) The third probability is that some factor in the kikuyu, not directly connected with the energy or protein fraction, affects the cows grazing kikuyu. Toxic substances, mineral deficiencies or pasture management could be involved.

Both Ca : P and K/Ca + Mg imbalances have been measured on kikuyu grazing.

A system of leader and follower grazing introduced into the herd grazing management appears to have eliminated most of the poor production potential of kikuyu in the autumn.

The use of the chemical fractions in kikuyu to predict its TDN was also investigated. This proved infeasable due to the poor relationship between the chemical fractions in kikuyu and its TDN as shown in Table 1.

TABLE 1 - The relationship between the chemical fractions and TDN in kikuyu herbage

TDN = 63,7 — 0,048	CP	r	=	-0,070	NS
TDN = 66,7 — 4,74	NPN	r	=	-0,360	NS
TDN = 64,8 — 0,079	CF	r	=	-0,080	NS
TDN = 63,0 — 0,005	NFE	r	=	-0,008	NS

The discrepancy between the nutritive value of kikuyu measured *in vivo* and actual animal production from kikuyu requires further research to determine what factors are responsible for the lower animal performance than is potentially possible from these pastures. The negative effect of the NPN fraction on DMI and digestibility needs to be studied in view of the high levels of nitrogen fertiliser applied to many kikuyu pastures.

• *Management*

THE EFFECT OF CERTAIN ENVIRONMENTAL CONDITIONS ON THE GROWTH, FUNCTIONAL DEVELOPMENT AND REPRODUCTION OF BEEF CATTLE IN SOME AREAS OF NATAL: THE EFFECT OF DIFFERENT BREEDING AND FEEDING AREAS. 1967-1970

S.F. Lesch and A. van Niekerk

The two areas chosen for this study were the Highland Sourveld (Bioclimate area 4e) and the Valley Thornveld (Bioclimate area 10). The Thabamhlope Research Station (Highveld Sourveld) is 415 m higher than the Onverwacht Research Station (Valley Thornveld). Mean summer maximum temperatures in the sourveld were 26 °C to 30 °C. Mean minimum temperatures were 0 °C to -3 °C. Mean summer maximum temperatures in the Thornveld were 33,5 °C and mean minimum temeperatures 4 to 6 °C. Thabamhlope receives on average 250 mm more rainfall p/a than the Onverwacht Research Station. Quality of grazing at both locations was similar but the topography varies considerably. Thabamhlope consists of exposed gently rolling hills whereas in the Thornveld the trees and shrubs afford some shade and shelter. The cows that were fed in "stalls" were reasonably well sheltered at both locations.

Nucleus breeding herds of Simmentaler and Afrikaner cows were maintained at both locations. At weaning half of the calves from each breed and of each sex were translocated to the alternate location. Half of the calves at each location were fed in stalls and the other half reared on veld.

Simmentaler cows had higher calving rates and weaned more calves than the Afrikaner cows at both locations. Cows (both breeds) in the sourveld had higher calving rates than the cows in the Thornveld, but weaned less calves the high mortality caused by the cold weather experienced in the Sourveld.

Heifers were transferred to the breeding herd once they had attained a mass of 318 kg. The steers were slaughtered at a minimum live mass of 411 kg.

In the Sourveld Simmentaler steers reached their final live mass faster than the Afrikaners in both the stall and veld feeding situation (92 days and 102 days, respectively), but this trend was not as evident in the Thornveld where both breeds responded similarly in both feeding situations. Heifers on the other hand showed different responses at the two locations. Simmentaler heifers fed in stalls reached their mating mass 70-80 days earlier than the Afrikaner at both locations whereas the Simmentalers on veld at Thabamhlope took 162 days less than their Afrikaner counterparts to reach their mating mass. At Onverwacht Afrikaners took on average only 34 days longer than the Simmentalers to achieve their mating mass of 318 kg.

Animals reared in the Sourveld consumed more dry matter per head per day than animals reared in the Thornveld. If location is ignored, Afrikaner heifers consumed 6,237 % more dry matter than the Simmentaler heifers. Location also affected efficiency of utilisation. Afrikaner heifers consumed 35,77 % more dry matter/kg gain in the Sourveld than in the Thornveld. Simmentaler heifers' feed conversions were 24,95 % higher in the Sourveld than in the Thornveld.

The information obtained from this trial highlights the fact that certain classes and types of beef cattle will perform significantly better in certain bioclimatic areas than others. This has obvious economic implications. It is suggested, therefore, that the need for breeding and feeding areas has good scientific foundation, but that the practical implications appear to be insurmountable.

• *Management*

N.5311/41/3/1:

LARGE STOCK: EFFECT OF SHADE UPON MILK PRODUCTION OF LACTATING CATTLE GRAZING SUMMER PASTURE IN THE HIGH RAINFALL SOURVELD AREAS AT CEDARA. 1982-1985

T.J. Dugmore

The objective of this study was to measure the effect, if any, upon milk production, of supplying shade to lactating dairy cows in summer in the Natal Midlands.

Sixteen Friesian cows, eight per treatment, were used in a randomised block design. One treatment (shade) was allowed access to a shade structure, constructed from 80 % shade cloth, on the pasture. The

control treatment was kept on the pasture with no access to shade.

The total milk production recorded for the two treatments did not differ significantly (3 477 versus 3 440 kg for the control and shade treatments, respectively). Daily maximum temperature and relative humidity readings were regressed on daily milk yields to establish if any relationship between these factors existed. No significant regression equations were found.

The mean daily maximum temperature during the trial period was 27,7 °C ± 3,5 which is slightly higher than the long-term average of 35,1 °C for Cedara. Therefore supplying a shade structure to grazing dairy cattle in the Natal Midlands does not appear to be justified.

SMALL STOCK

• *Reproduction*

V.5312/04/1/1: SMALL STOCK: THE INFLUENCE OF SEASON OF BIRTH ON PUBERTY, SEMEN PRODUCTION AND LH LEVELS OF KARAKUL RAMS AT THE KARAKUL RESEARCH STATION. 1980-1986

A.S. Faure

The influence of season of birth on the sexual development of Karakul rams up to an age of 42 months was investigated. Parameters measured were age, body mass, testis circumference, mating proficiency, libido, semen properties and hormone levels (LH and testosterone).

A highly positive correlation ($r = 0,70$ to $0,99$) existed between the body mass and testicular circumference in ram lambs during the developmental stage, after which the relationship decreased.

During the developmental stage the testis circumference increased at a higher rate than body mass over a period ranging from 79 to 161 days of age. Day length did not influence the testicular circumference during the developmental stage in ram lambs, but thereafter and independent of body mass, testicular circumference changed inversely with length of day.

Season of birth in ram lambs did not affect ($P > 0,05$) the average age, body mass and testicular circumference at either anatomical (penial release) nor physiological (first sperm in ejaculate) puberty, which occurred at, respectively, 129,00 ± 21,37 and 143,36 ± 17,57 days; 31,99 ± 3,53 and 33,96 ± 4,01 kg; 11,28 ± 1,40 and 12,69 ± 1,17 cm during the rapid testicular growth stage.

Semen volume, colour, motility, sperm concentration and percentage dead and abnormal sperm of pen-fed Karakul ram lambs increased from approximately 20 to 60 weeks of age, whereafter it stabilised for the remainder of the experimental period. Changes owing to seasonal influences did not occur in this study.

Sexual maturity, defined as first successful mating, developed significantly slower ($P < 0,05$) during long as compared with short day lengths and occurred for the first time after the rapid stage of testicular growth. At the time semen properties were of sufficient quality to effect fertilisation. Mating proficiency (number of successful matings) in rams increased gradually up to an age of 16 and 17 months. During this period an increase in the number of successful matings was characterised by a decrease in the number of attempts to mate. Libido, measured as the number of successful matings, was found to be lower during long day lengths. Seasonal influences were, therefore, apparent.

The average plasma LH and testosterone concentration of ram lambs born during summer, winter and spring showed a similar tendency from birth onwards. The average testosterone concentration gradually increased during the developmental stage from basal levels at birth, after which it followed seasonal changes that varied inversely with length of day. A relationship was found between LH and testosterone levels in adult rams at the beginning of the breeding season, while only an indication of such a relationship existed in developing ram lambs.

Results obtained provided sufficient evidence that the Karakul ram lamb can reproduce successfully early in life, which is desirable to enhance reproduction.

SMALL STOCK

• *Reproduction*

V.5312/04/1/2: SMALL STOCK: THE INFLUENCE OF NUTRITION AND ESTROGENS ON THE REPRODUCTION OF YOUNG KARAKUL EWES AT THE KARAKUL RESEARCH STATION. 1979-1986

A.S. Faure

The influence of season of birth, nutrition and exogenous oestrogen on the sexual development,

hormone levels (LH and total oestrogen) in Karakul ewes until after their first breeding season and reproduction up to an age of 48 months, was investigated. Apart from hormone levels, parameters such as age, body mass, vaginal mucus fern pattern formation, *post-partum* period to reconception and number of lambs born, were measured.

Season of birth significantly ($P < 0,05$) influenced the age at which sexual maturity was reached in ewe lambs. The longer they were born prior to the next breeding season, the older ewe lambs became before sexual maturity was reached. In general, ewe lambs attained sexual maturity in the same order during the subsequent breeding season as sequence of birth. Age and body mass of ewe lambs at the time of sexual maturity was significantly ($P < 0,05$) affected by nutrition. The average body mass at sexual maturity was reflected by their age at that time, as well as the preceding nutritional condittions. Higher nutritional levels improved reproductive ability of ewes. Nutrition also influenced first partus mass highly significantly ($P < 0,001$).

The closer ewes were born to the next breeding season, the more adversely oestrogen treatment (2 mg oestrogen, weekly from 90 to 245 days of age) affected the age at sexual maturity, as well as their reproductive ability. During the effective treatment period at the 2 mg level, oestrogen significantly ($P < 0,05$) increased body mass when supported by optimum nutritional conditions.

The vaginal smear technique was found to be most successful for the detection of intra-vaginal spermatozoa, especially if samples could be taken daily during the time of expected conception. The method however, failed to detect first oestrus in lambs because of the absence of cyclic fern pattern formation and degenerative epithelial cells as found in adult ewes.

Ewe lambs (0 mg oestrogen level) born during summer, winter and spring exhibited similar patterns of average plasma LH and oestrogen concentrations between birth and sexual maturity. No absolute difference in concentration patterns of either LH or oestrogen could be seen between the 0 and 2 mg levels of oestrogen treatment groups of ewe lambs during the experimental period, and these parameters could therefore, not explain the decidedly poorer fertility of the latter animals.

Results obtained provided sufficient evidence that the Karakul ewe lambs (non-lactating) can reproduce successfully early in life which is desirable to enhance reproduction. It also emphasised the importance of optimal nutrition to promote sexual development and reproduction.

SMALL STOCK

- *Nutrition*

V.5312/05/3/3: THE EFFECT OF DIFFERENT LEVELS OF CRUDE PROTEIN AND ENERGY SUPPLEMENTS TO LACTATING EWES ON NATIVE PASTURE AT GLEN, 1979-1986

H.O. de Waal

The effect of different levels of energy and crude protein supplements to lactating Merino Dorper ewes on the performance of the ewes and their lambs while grazing native pasture of the central Orange Free State at Glen, was studied over a period of four years. The trial periods included two autumn (1981 and 1982) and two spring (1983 and 1984) lambing seasons.

Prior to *partum* all ewes were fitted with permanent rumen cunnulae. The different levels and combinations of supplementary energy and crude protein were provided daily directly into the rumen of the lactating ewes.

The body mass loss of lactating Dorper and Merino ewes could not be reduced by providing either supplementary energy (100 g or 200 g maize meal) or crude protein (60 g high protein concentrate) during the autumn/winter on native pasture, while the daily gain of their lambs was only slightly increased. However, the body mass loss of lactating Dorper and Merino ewes was reduced by 50 % and the daily gain of their lambs increased markedly by providing a combined supplement of energy and crude protein (100 g or 200 g maize meal plus 60 g HPC). Irrespective of treatment, the Dorper ewes lost 100 % more in body mass during lactation than the Merino ewes, but their lambs gained 100 % faster than the Merino lambs. The different supplements had no effect on wool production by the Merino ewes.

By contrast, provision of similar supplements (1983), or incremental levels of energy (1984 - 150; 300 or 450 g maize meal) during the spring/early summer to lactating Dorper ewes, had no definite effect on the body mass changes of the ewes or the daily gain of their lambs.

The intake of digestible organic matter (DOMI) by the lactating ewes, both from the pasture as well as

the respective supplements, corresponded with the observed performance of the ewes and their lambs in the different treatment groups as well as between seasons.

Diurnal changes in rumen pH and NH_3 concentration, as well as the rate of fermentation (*in situ* disappearance of DM from nylon bags) of samples collected by oesophageally fistulated sheep and incubated in the rumen of the free ranging lactating ewes, were also studied.

The results of these studies contradict and challenge in many respects the methods, as well as the principles involved in which the myriad of energy and crude protein containing supplements are provided to sheep grazing native pasture in the central Orange Free State.

SMALL STOCK

• *Upgrading*

K.5312/07/1/4: THE SLAUGHTER AND CARCASS CHARACTERISTICS OF AFRINO X MERINO LAMBS IN COMPARISON TO THAT OF THE PARENT BREEDS OF THE AFRINO AND THE DORPER. 1983-1987

J.J. Olivier

Four groups of 50 Merino ewes were mated to four Ronderib Afrikaner (RA), four Merino (M), four S.A. Mutton Merino (SAVM) and four Afrino (A) rams during the autumn of 1983, 1984 and 1985. During 1983 a further 50 Merino ewes were mated to four Dorper rams, whereas in 1984 and 1985 four Afrino rams were mated to 50 F3 and F4 Afrino ewes. All the groups were maintained as one flock under natural veld conditions at the Carnarvon Experimental Farm. All F1 progeny except those born in 1985 were slaughtered as follows:

25 % at 100 days
25 % at 120 days
25 % at 35 kg live mass and
25 % at 40 kg live mass

Lambs born during 1985 were kept on the veld after weaning; finished off in a feed lot and slaughtered at 40 kg live mass.

According to the results the carcasses of all the groups were too light and too lean when slaughtered at either 100 or 120 days of age. The best carcasses were obtained when lambs were slaughtered at 40 kg live mass. With the exception of the M x M group, no significant differences were found between the other groups when slaughtered at 40 kg live mass. Under veld conditions the Merino took 247 days to reach 40 kg (carcass mass of 14,5 kg) compared to the other groups which took only 200-207 days (carcass mass of 16,07-17,24 kg) to reach this mass. The same results were found with the lambs in the feed lot. The Afrino x Merino cross lambs did not out perform any of the other cross-bred lambs.

SMALL STOCK

• *Potential studies*

D.5312/36/1/1: SMALL STOCK: INTEGRATION OF WOOLLED MUTTON SHEEP IN THE EASTERN SEABOARD OF THE EASTERN CAPE. 1959-1976

F.O.C.W. Karberg

Introduction

Farms in the eastern seaboard are generally small, being 300 to 400 ha in extent. Historically it is characterised by monoculture with pineapple and chicory as dominant agronomic practices. Animal production has played mainly a secondary role with the emphasis on beef and dairy production. Sheep production was seldom considered and played a negligible role. However, the natural resources of the area lend itself to intensified animal production systems based on pastures and fodder crops. Also introduction of well planned sheep production systems into the agronomic rotations could lead to greater economic stability. For this purpose a breeding flock of Dohne Merinos was started at the Bathurst Research Station in 1959 to

examine the possible role of sheep. Initially a semi-intensive system based on pastures and veld with a single spring lambing season was investigated. With improved forage production it was possible to intensify the frequency of lambing (three lamb crops in two years) and the finishing of lambs in battery-feeding systems.

The following are major aspects of the study:

Semi-intensive systems

Systems of lamb production based on combinations of veld and a variety of pastures (lucerne and oats) are viable alternatives to beef farming irrespective whether autumn and/or spring lambing seasons are practised. Reproduction rates (lambs born/ewes mated) varied from 80 % and higher for6 autumn lambings to 120 % for spring lambing. Approximately 90 % of lambs were weaned. Lamb-gains (174 g ADG) at 150 day weaning were non-significantly lower than at 100 day (191 g ADG) weaning.

The frequent breeding system

This system was based on veld (15 %) and established pastures (85 %) with kikuyu, lucerne and oats as the major components. The viability of the frequent lambing system was largely dependent on the influence of the seasonal rainfall distribution on forage production. Good spring and early summer rains were necessary to bridge the mid-summer dry period. Similarly good autumn and winter rains are essential to ensure a sufficient feed-flow during winter and early spring. Poor rainfall distribution was often the major draw-back in this all-the-year-round rainfall area for such highly geared lamb production systems and when stocked at the near maximum of 12 ewes/ha and grazed at stocking densities ranging from 200 to 250 s.s.u. per ha. Back-up feeding strategies are a prerequisite to the viability of a system of three lamb crops within a period of two years.

Irrespective of the lambing seasons (summer, spring, autumn) the reproduction rate was on average 96 %. Weaning percentage was 96 % for lambs weaned at 56 days of age and finished-off under penned conditions. Lambs gained at the rate of 247 g/d for the pre-weaning phase to 214 g/d during feed-lotting; thus producing a slaughter lamb of 35 kg at the age of 22 weeks. Compared to a single lambing season the lamb-output per ewe was raised from 1,17 to 1,75 lambs/ewe/annum. This was achieved without artificial manipulation of ovarian activity.

Environmental influences

The influence of environmental factors on production traits were at variance between systems of 8-month or 12-month breeding frequencies. Ewe age indicated minor influences on gestation or lactation masses between systems. Differences within the 8-month system originated mainly from the fact that maiden ewes were mated at the age of 10 month and at an average body mass of 45 kg; the latter being 70 to 80 % of mature body size. Ewe age significantly influenced the reproduction efficiency. Within the 12-month system optimum reproduction rate was realised at 72 months. In the 8-month system the maximum number of lambs born (1,07) and weaned (0,94) occurred at 55 months of age. The high physiological drainage in ewes in frequent breeding systems often required extra feeding to maintain a high energy-status during all physiological phases to sustain a high lamb output.

Seasons exerted a major influence on most production traits. This was found to be the major factor responsible for observed differences between the two systems. When data were corrected for seasons, birth and weaning status significantly influenced lamb growth within a system. Sex of lamb played a lesser role.

Wool

Annual unscoured wool yields were 4,2 kg and 4,6 kg for mature ewes and maiden ewes, respectively. Even wool yields were sensitive to frequent breeding practices and decreased linearly at a rate of 0,1 kg for each consecutive 8-month breeding cycle.

Economics

Gross income per small stock unit (s.s.u.) was R36,39 of which 74 % was derived from capital return (mutton). Gross margins were R9,68/s.s.u. with a nett return of R95/ha/annum calculated at 1985 product prices.

nclusion

Various sheep breeding systems can be successfully implemented as alternative stock enterprices in the l-year-rainfall coastal belt of the Eastern Cape to intensify animal production. Such sheep production stems will stabilise financial returns and will help to eliminate mono-agronomic practices.

SMALL STOCK

Management

.5312/41/1/2: INCREASED MUTTON PRODUCTION BASED ON THE DORPER AT GLEN. 1981-1986

C.J. Louw

Dorper and Romanov x Dorper ewes were produced in such a manner that each strain was divided nto two age groups. The one group obtained puberty within the breeding season (autumn to winter) and the ther outside the breeding season (spring to summer). The ewes were mated to Dorper rams at 11 months of ge and were evaluated in a system of three lambing seasons over a period of two years. Evaluation was one on reproductive performance, lamb growth and carcass grading. The aim of this study was to nvestigate the possibility of increasing the profitability of lamb production in a semi-intensive production ystem.

Cross-bred ewes obtained puberty earlier and at a lower body mass than Dorper ewes within the reeding season. This tendency was reversed outside the breeding season.

The reproductive performance of cross-bred ewes was superior to that of Dorper ewes. The erformance of cross-bred and Dorper ewes, respectively, was 97,1 *versus* 90,9 % in terms of number of ewes ambing per 100 ewes joined, 198,6 *versus* 141,8 % in terms of fecundity and 154,0 *versus* 98,5 % for number of lambs weaned per 100 ewes joined.

The F1-ram lambs ($\frac{1}{2}$ Romanov : $\frac{1}{2}$ Dorper) had higher pre-weaning (291 *versus* 270 g/day) and ost-weaning growth rates (339 *versus* 332 g/day) than the Dorper lambs. The situation was reversed with he F2-lambs ($\frac{1}{4}$ Romanov : $\frac{3}{4}$ Dorper).

Twin lambs were inferior to single lambs only in terms of birth mass and pre-weaning growth rates but displayed similar growth rates after weaning.

The most pronounced differences between the two strains in terms of carcass traits were found in fat thickness and distribution. These differences were reflected in the grading of the carcasses (Dorpers : 66,4 % Super and 33,6 % Lamb 2; Cross-breds : 92,9 % Super, 0,5 % Lamb 1 and 6,6 % Lamb 2).

Although a highly prolific ewe group was produced, the F2 lambs could not maintain the growth rate of Dorper lambs. Investigation on the utilisation of a third ram breed to improve the rather disappointing growth rate of F2 lambs is at present under way.

A cross-breeding production system as investigated in this trial, is highly dependent on prevailing mutton price to feed price ratio.

SMALL STOCK

• *Norm studies*

K.5312/50/1/5: THE INFLUENCE OF FEEDING CHOCOLATE MAIZE- ROUGHAGE DIET ON THE PRODUCTION AND QUALITY OF MOHAIR PRODUCED BY GROWING AND ADULT ANGORA GOATS. 1984-1986

P.D. Grobbelaar and Verena Hobson

The influence of feeding different levels of chocolate maize and lucerne hay on the production and quality of mohair produced by growing and adult Angora goats was investigated. Four different rations were used, namely:

100 % chocolate maize + 0 % lucerne hay
90 % chocolate maize + 10 % lucerne hay
80 % chocolate maize + 20 % lucerne hay
70 % chocolate maize + 30 % lucerne hay

Fourty adult Angora ewes and forty Angora kids (5 months old) were divided into eight groups of five each. Four groups received the above-mentioned rations on a group base and the remaining groups the same four rations but on an individual base. As a result of a severe outbreak of coccidiosis amongst the young animals, they received the different levels of feeding only on a group base. The outbreak was so severe that no conclusions could be made from the data of the kids.

Mohair samples were taken at the end of the trial period and were analysed for the different physical and chemical properties such as hair mass (raw and clean) fibre diameter and variation along the fibre, lock and straight length of the fibre, percentage hair wax and suint as well as the pH of the suint.

The daily intake of the rations were the least for ration 1 (100 % chocolate maize) and the highest for ration 2 (90 % chocolate maize + 10 % lucerne hay).

At the end of the trial period no significant differences in body mass occurred although group 2 (10 % lucerne hay) with the highest feed intake also had the highest body mass. The 100 % chocolate maize group had the lowest body mass. No significant differences in the production and the quality of the adult mohair occurred between the different groups.

It seems that the animals performed better on the 90 % chocolate maize + 10 % lucerne hay ration (no significant differences occurred), but animals can be kept on a 100 % chocolate maize ration and still maintain a good production. In the case of kids, coccidiosis can be a serious problem and should be taken into account. Coccidiosis is currently well controlled by the inclusion of anti-biotic ionophores in the feed.

Non-ruminants

PIGS

• *Nutrition*

W.5322/05/2/1: AN INVESTIGATION INTO FACTORS AFFECTING THE PRE-WEANING CREEP FEED INTAKE AND GROWTH PERFORMANCE OF PIGLETS.
1981-1986
N.M. Kritzinger

Observations were made on growth performance of piglets receiving pre- and post-weaning creep feed. Regressions and correlations of pre- and post-weaning feed intake on different parameters such as parity, litter size, daily gain, feed conversion etc. were calculated.

Material and methods

Results obtained from 236 litters produced during the period 1981 to 1985 at Elsenburg, are included in this report.

The experimental animals were grouped in litters and managed according to a standard management programme. A commercially available creep pellet diet was provided from 10 days of age. The piglets were weaned at precisely 35 days of age, whereafter they were kept for a further two weeks in the weaning crates and received the same diet, *ad libitum*.

Data collected included litter size, birth mass, 10-day live mass, 35-day live mass, creep feed intake until 35 days of age, 49-day live mass and post-weaning creep feed intake until 49 days of age. Breed, age of sow and parity were also noted (Table 1).

TABLE 1 - Mean values (± standard deviation) of the different parameters for the litters included in the experiment

Parameters	Average	Std. deviation
Parity	4,559	2,840
Litter size	9,114	1,932
Birth mass (kg)	1,342	0,219
10-day mass (kg)	3,164	0,570
35-day mass (kg)	9,102	1,278
Pre-weaning feed intake (kg)	1,151	0,776
49-day mass (kg)	12,726	2,485
Post-weaning feed intake (kg)	6,996	2,218
Pre-weaning daily gain (kg)	0,238	0,045
Post-weaning daily gain (kg)	0,260	0,124
Feed conversion ratio*	2,298	1,627

*for the period between weaning (35 days of age) and 49 days of age

Results and conclusions

With regard to the intake of creep feed, large variation occurred between the various litters. Although positively correlated with litter size, parameters such as birth mass, 10-day live mass and parity were independent of pre-weaning creep feed intake. Pre-weaning creep feed intake was positively correlated with post-weaning creep feed intake and the growth performance of the piglets. Furthermore, the intake of creep feed just after weaning was positively correlated with post-weaning performance (Table 2). Alternative formulations for creep diets will have to be found in order to maximise intake of quality feedstuffs.

TABLE 2 - Linear regressions (with corresponding correlation coefficients) of pre- and post-weaning feed intake on the different parameters

Parameters	Regression	
	Pre-weaning feed intake	Post-weaning feed intake
Parity	Y = 0,020X + 1,059(r=0,075)	Y = 0,108X + 6,503(r=0,139)
Litter size	Y = 0,093X + 0,307(r=0,231*)	Y = 0,002X + 6,980(r=0,002)
Birth mass	Y = 0,196X + 0,888(r=0,055)	Y = 2,816X + 3,218(r=0,278**)
10-day mass	Y = -0,122X + 1,540(r=0,090)	Y = 1,001X + 3,831(r=0,257**)
35-day mass	Y = 0,635X + 8,370(r=0,386**)	Y = 0,979X + 1,912(r=0,533**)
49-day mass	Y = 1,600X + 10,830(r=0,50**)	Y = 0,957X + 6,030(r=0,854**)
Pre-weaning daily gain	Y = 0,028X + 0,205(r=0,481**)	Y = 24,890X + 1,085(r=0,508**)
Post-weaning daily gain	Y = 0,069X + 0,179(r=0,432**)	Y = 0,045X + 0,057(r=0,805**)
Feed conversion ratio	Y = -0,416X + 2,778(r=-0,199*)	Y = 0,178X + 3,584(r=-0,244*)

* Significant (P 0,05)
**Significant (P 0,01)

RESOURCE UTILISATION RESEARCH (PASTURES)

Regional pasture

VELD

• *Pests*

N.5411/20/1/1: INSECTS DAMAGING VELD. 1970-1986
P.C Joubert

Some insect pests of veld, not previously investigated, were studied during the fifteen-year period 1970 to 1985. In each case the economic status of the insect was determined. If proved positive and important, the insect's life cycle, biology and ecology were studied in order to explain its pest status and to devise practical means of control, where possible.

The following insects were involved:

1. The Natal ghost moth (*Dalaca rufescens* H m psn) Hepialidae
2. The meristem complex:
   (a) The meristem midge (*Oscinella truncata* Sabrosky) Chloropidae
   (b) The meristem moth (*Ephysteris chersaea* Meyr.) Gelechiidae
   (c) The meristem weevil (*Elattocerus* sp.) Curculionidae
   (d) The meristem beetle (*Agrilus* sp.) Buprestidae
3. The army worm (*Spodoptera exempta*) Noctuidae

The ghost moth

It was found that this insect eradicated pastures and caused serious deterioration of utilised veld, converting climax veld to a stand of pioneer grasses and weeds. During average and above-average rainfall years, this deterioration proceeds at a rate of one per cent per annum. Recovery of damaged veld has not taken place over a period of fifteen years. This is the major reason for the existence of N'gongoni veld and

also for the replacement of *Cynodon* sp. by *Paspalum notatum* on playing fields. Control by knowledgeable management was recommended. Biological control was found to be promising with the use of *Beauveria* sp.

The meristem complex

All the insects involved were found to consume the contents of grass tillers, including the meristems, thus killing the tillers and stopping growth for a month or more in spring. During summer the growing tips are followed upwards and finally the contents of the florets are devoured. Loss of yield amounts to millions per annum, especially in the *Themeda*/Thornveld. Because of the wide distribution of these insects, control seems impractical, but knowledge of their presence is essential when conducting pasture experiments as they may significantly influence the yield obtained.

The army worm

Through a nine-year study (intermittent) of the movements of the alates of the army worm (*Spodoptera exempta*) it was established that this insect's southward migration over Africa is correlated with high-pressure weather systems.

VELD

• *Ecology*

D.5411/27/1/1: VELD: THE EFFECT OF *A. KARROO* ON THE BASAL COVER, SPECIES COMPOSITION OF THE HERBACIOUS COMMUNITY IN THE CENTRAL GRASSVELD. 1982-1986

G.C Stuart-Hill

It is essential that the competitive interaction between *A. karroo* and the herbaceous layer be examined within a community model. The objective of this chapter was to review an existing community model (Aucamp, *et al.*, 1983) and introduce improvements where necessary.

Three refinements were made to the traditional model:

(i) Total forage production was estimated in terms of TDN and not simply by adding together, on a dry matter basis, browse and grass yields.
(ii) The error in the traditional model caused by extrapolating livestock production (and hence profitability) with increasing bush density, was eliminated.
(iii) Grazer stocking rates were reduced to compensate for the amount of grass eaten by goats.

With these refinements, the model predicted that maximum TDN would be attained at 1 220 TE per ha, maximum live mass production at 1 320 TE per ha and maximum profit (gross margin) at 1 000 TE per ha. This compares with 847, 2 600 and 1 620 TE per ha for each, respectively, in the traditional model. As a direct consequence, the traditional model over-estimated the potential for livestock production by approximately 51 % and generally presented an over-optimistic view of bush utilisation.

Because of the ecological risks associated with high bush densities, together with the absence of any advantage in having more than 1 320 TE per ha, it was recommended that such a tree density should never be exceeded. Should this occur, excess trees must be removed (in order of decreasing height) until a density of 1 320 TE per ha or less is attained.

It was estimated that the system would be severely over-stocked (by up to 67 %) if grazer numbers were not reduced to account for the amount of grass eaten by goats. Consequently, grazer stocking rates should be reduced (over and above the reduction to account for the competitiveness of the tree) by 20 % of browser stocking rates if winter browse is available for goats (e.g. evergreen bush), or by 40 % if during winter, goats have to subsist entirely on the grass layer (i.e. when *A. karroo* loses its leaves).

The traditional model did not account for the increased competitiveness which *A. karroo* trees display when defoliated. However, it was not possible to include this factor into the model's refinements as it had not been quantified in terms of tree density. It is recommended that, because the influence of tree defoliation is so large (40 % reduction in grass productivity), it should be investigated as a matter of urgency.

An algorithm was developed to include, in an applied manner, the implications of the refined model in

determining the long-term stocking rates for grazers and browsers. The algorithm was intended for land operators within *A. karroo* dominated savanna, as a formal procedure which can be updated and modified as additional information becomes available.

Finally it is recommended that future research should approach the following questions:

(i) What is the influence of tree defoliation on grass production at various tree densities?
(ii) Does the model hold over all veld conditions?
(iii) Does the model hold for other bush species occurring in the region?
(iv) How do differences in seasonal rainfall influence the model?
(v) What is the number of browse units necessary per goat in various situations (slopes, soil types, rainfall, aspect, etc.).

VELD

• *Crop science*

TOWARDS IMPROVED LIVESTOCK PRODUCTION FROM SWEET GRASSVELD. 1985

J.E. Danckwerts (Ph.D.(Agric.), Univ. Natal) Supervisor: Prof. N.M. Tainton

An investigation was undertaken to provide quantitative means towards improved livestock production from sweet grassveld with particular reference to the False Thornveld of the Eastern Cape. As a first step, a trial was initiated to identify key grass species in the veld type. On the basis of their widespread abundance, forage yield and acceptability to livestock, *Themeda triandra* (a decreaser species) and *Sporobolus fibriatus* (an increaser species) were identified as key grasses.

Research on the ontogeny, physiology, response to moisture stress and response to dipping revealed that both *T. triandra* and *S. fimbriatus* possess many characteristics enabling them to survive defoliation. Defoliation appears to be obligatory for vegetative persistence of *T. triandra*, and emergence of potentially viable lateral tillers of the species is best stimulated by severe defoliation during the growing season. In contrast, production of lateral tillers of *S. fibriatus* is not as affected by time of year. *Sporobolus fimbriatus* is, however, better adapted to both frequent and intense defoliation during the growing season and has better developed physical deterrents to herbivory than *T. triandra*. It is therefore concluded that *T. triandra* is better adapted to fibre during the dormant season than *S. fimbriatus*, while the latter is better adapted to year-long herbivory.

The following hypothesis is thus put forward: *T. triandra* is well-adapted to a situation of relatively frequent (inter-season) fire and no more than modest herbivory; *S. fimbriatus* is well-adapted to a situation of heavy (within-season) herbivore usage, but infrequent fire.

It was contended that maintainance and/or an increase in the proportion of T. triandra in the veld is a prerequisite towards achieving this objective. It was further suggested that in order to do this, defoliation strategies must at least periodically simulate what would happen under a regime of relatively frequent fire accompanied by no more than moderate herbivory. This can be implemented in practice by use of fire followed by resting. Alternatively, the treatment that would be applied in a fire regime could be simulated by critical herbivore management strategies. The latter alternative is more attractive to pastoralists in semi-arid grassveld since it precludes wastage of herbage through combustion.

Studies of the dynamics of forage availability, animal intake per head and sward defoliation patterns showed that such critical herbivore management strategies involve the essential prerequisites in sweet grassveld:

1. Stocking rates should be conservative and no higher than the grazing capacity (for commercial pastoralism) of the veld.
2. Rotational resting of a third of the veld for a full growing season each year.
3. Rotational grazing of non-rested veld within a multi-camp system. The basis for the rotation should be periods of absence of 90 to 150 days, and period of occupation of two to three weeks.

Of particular note is that most of the proposed guidelines emanating from the research reported in this dissertation were intuitively applied on the renowned conservation farm "Tukulu". "Tukulu" has become synonymous with the concept of economically viable veld management and conservation in sweet grassveld. The achievements on this property are evidence that the goal of improved livestock production from sweet grassveld is attainable.

• *Potential studies*

K.5411/36/1/1: CARRYING CAPACITY NORMS: DETERMINATION OF BIOMASS AND PRODUCTION OF ELEVEN VELD TYPES IN THE KAROO REGION. 1978-1986

P. Botha

The phytomass of 146 plant species in the eleven most important veld types in the Karoo Region was determined quarterly over a five-year period by means of clipping trials. The species were distributed in the Region as follows:

- Thirty-seven species in three veld types on 14 localities in the North-western Karoo
- Thirty-seven species on 10 localities in three veld types in the Karoo Midlands
- Thirty-two species on 16 localities in four veld types in the North-eastern Karoo
- Forty species in the Great Karoo in three veld types on 13 localities

The plant material was subjectively separated in edible and inedible material. The average phytomass per plant for the different seasons is presented in the form of a table.

The chemical composition of the edible material was determined by means of standard procedures in respect of the following: ether extract, fibre, ash, nitrogen, sodium, potassium, calcium, magnesium and phosphorus. The average chemical composition of the plant species during the different seasons of the year was indicated.

• *Potential studies*

K.5411/36/1/2 CARRYING CAPACITY NORMS: DETERMINATION OF THE BIOMASS AND PRODUCTION OF THE VEGETATION OF THE MEENTSPRUIT FARMING UNIT IN VARIOUS PHENOLOGICAL STAGES. 1979-1986

P. Botha

The phytomass of 28 species on seven topographical units on the Meentspruit farming unit situated in the False Upper Karoo veld type was determined monthly over a five-year period by means of clipping trials. The average seasonal phytomass of the different species is presented in the form of a table.

The chemical composition of the edible material was determined by means of standard procedures. The following was determined: ether extract, fibre, ash, nitrogen, sodium, calcium, magnesium, potassium and phosphorus. The average chemical composition of the species during the different seasons was indicated.

• *Management*

K.5411/41/1/3 THE EFFECT OF SHEEP TREADING AND GRAZING ON PLANT AND SOIL CHARACTERISTICS OF MIXED KAROOVELD. 1984-1987

G. van N. du Toit

The study was undertaken at the Grootfontein College of Agriculture with the main object of determining the short-term effect of stocking density on certain plant and soil characteristics of mixed Karooveld. The soil form of the studied areas was a Valsrivier of the Zuiderzee series.

The four stocking densities applied were: control, 4 sheep/ha, 8 sheep/ha and 16 sheep/ha. There were two replications for each stocking density and two grazing periods of 30 days each. Vegetation characteristics surveyed were basal, canopy and regime cover. Soil parameters included infiltration tempo, soil compaction

and bulk density. Plant material lost by trampling and the dung distribution of the sheep were also measured.

There was a linear decrease in basal, canopy and regime cover evident when stocking density was increased. The declivity of the graph increased with an increase in the original percentage cover. Because of the rejuvination of the vegetation, the regrowth after grazing was highest after the highest stocking density had been applied. A light stocking density (4 sheep/ha) had the least effect on all the vegetation parameters.

No grazing (0 sheep/ha) and a high stocking density (16 sheep/ha) both lead to a decrease in infiltration tempo. The first because of a puddling of the soil surface and the second because of a compaction of the lower soil strata.

The bulk density of the soil increased whilst the penetrability of the soil decreased with an increase in stocking density. Trampling losses increased parallel to an increase in stocking density. Trampling losses per animal decreased and showed a flattening in the graph with an increase in stocking density. Dung distribution increased linearly with an increase in stocking density. Approximately 80% of all dung was excreted on about 10% of the camp area. Dung excretion per animal decreased linearly with an increase in stocking density. It was concluded that there is still a lack of knowledge concerning the influence of length of grazing period on soil characteristics, the time necessary for recovery after grazing and the influence of stocking density on other soil types.

VELD

• *Management*

N.5411/41/1/8: FERTILISATION OF GRASSVELD TO DETERMINE YIELDS AND SPECIES CHANGES AS A RESULT OF CUTTING. 1950-1987

P.C.V. du Toit

Attempts to improve the productivity of rangeland (veld) have been successful in many parts of the world. Many of the soils in South Africa are inherently low in phosphate and in Natal this is compounded by high levels of exchangeable aluminium. Such harsh soil conditions do not provide a potential for high yields unless some form of soil amelioration is practised. The original concept of this experiment therefore was not unreasonable, particularly in the light of success elsewhere in the world. It was clear that the application of fertiliser has resulted in an increased production of dry matter, but unfortunately the quality of that dry matter is not known. It is suggested therefore that should this experiment be maintained that the forage quality and forage flow aspects be considered in detail so that the true impact of changes in species composition can be ascertained. Apart from this, the experiment now stands as an excellent demonstration as well as a laboratory of simulated veld conditions which can be used for autecological or synecological studies of both individual species as well as swards of a particular composition. Very little is known of the forage production potential of much of Natal's veld and this is especially true of degraded veld. This experiment could well provide research material from which much valuable information could be gained.

A final recommendation therefore would be to terminate the experiment in terms of its original objectives but maintain the treatments (at very low cost) to be used as a valuable demonstration as well as a basis for work on forage quality and forage flow.

VELD

• *Management*

N.5411/41/1/9: A COMPARISON OF THREE DIFFERENT INTENSITIES OF STOCKING; ROTATIONAL GRAZING AND RESTING OF VELD. 1948-1987

P.C.V. du Toit

The initial results of this trial, which outlined seasonal growth patterns of the veld and described intake by the animals under different treatment conditions, were reported by Tainton (1958). The most important results of the early phase of the trial were as follows:

(i) The difference method of determining intake and seasonal patterns of dry matter production proved to

be unsatisfactory. The sample areas required would have needed to have been too large to make the method practical, and the destructive nature of sampling interfered greatly with the grazing patterns of sheep. This component of the project was therefore abandoned after two seasons.

(ii) Early results suggested that the high stocking rates would have been economic in the short term. Animals individually performed better at light stocking rates, but production per unit area was greatest at high stocking rates. However, a warning was issued that this effect may be only short lived since the high stocking rate may lead to veld degradation.

(iii) The trial showed conclusively that high stocking rates reduced the length of the grazing season (in contrast to the belief at the time that the fresh growth stimulated by heavy grazing in a mixed veld would carry the animals for longer into the winter season). At heavy stocking rates, sheep reached peak seasonal mass in March, but continued to gain through to May in at least some of the lighter stocking rate treatments.

(iv) None of the systems was found to be sufficiently flexible to eliminate selective grazing.

(v) Both grazing system and stocking rate influenced the amount of seed produced by the veld plants.

(vi) Area selection was found to be much more prominent than species selection, except that the sheep selected strongly against *Aristida junciformis*. Grazing patterns were, however, affected greatly by the management system applied. For example, where a spring rest was provided, the sheep showed a preference for *Themeda triandra* over *Hyparrhenia hirta* during the summer grazing period, but these two species were equally acceptable following spring grazing.

(vii) The sheep seldom grazed an entire tuft at one grazing. They tended to graze a portion of a tuft and then move on, repeatedly returning to any particular tuft until it was grazed short. Having grazed a tuft in this way, they then returned at intervals to the same tuft to remove any new regrowth.

(viii) Heavy utilisation was shown to dramatically reduce root growth.

RADICAL VELD IMPROVEMENT

• *Crop Science*

T.5412/30/1/2: ESTABLISHMENT OF PERENNIAL SUB-TROPICAL PASTURE LEGUME INTRODUCTIONS IN NATURAL VELD IN THE SUMMER RAINFALL CROPPING AREA OF THE SOUTH-EASTERN TRANSVAAL. 1974-1985

D.L. Barnes

The feasibility and potential of reinforcing veld with legumes in the south-eastern Transvaal highveld was assessed in a number of trials during the period 1974-1984. Experience was gained with regard to methods of establishment, adaptation of legumes to the local environment, responses to fertilisation especially with lime and superphosphate, and the reaction of legumes to fire and grazing.

In all, 17 legumes were involved, including the genera *Coronilla, Desmodium, Glycine, Lespedeza, Lotus, Macroptilium, Medicago, Neotononia, Trifolium* and *Vigna*. Only *Coronilla varia* (crown vetch) showed a satisfactory degree of persistence. However, crown vetch is slow to establish, is intolerant of waterlogging and has a relatively high requirement for lime and phosphate. Considering these features, and the probability of undesirable changes in grass species composition in reinforced veld, it is recommended that intensification be achieved through development of improved pastures for use in conjunction with veld, rather than by means of veld reinforcement.

RADICAL VELD IMPROVEMENT

• *Evaluation*

THE INTRODUCTION AND EVALUATION OF PROMISING PASTURE SPECIES IN THE EASTERN CAPE: SCREENING OF SPECIES FOR VELD REINFORCEMENT IN THE DOHNE SOURVELD. 1975-1980

C.J.G. le Roux

The natural vegetation of the Dohne sourveld has a low nutritional value and carrying capacity. Its climate is however suitable for intensified pasture production.

Six grasses and seven legume cultivars were screened for suitability in the reinforcement of Dohne sourveld. Cocksfoot, Kentucky 31 fescue and *Phalaris tuberosa* seem suitable for the purpose. The use of Whittet kikuyu is restricted in some areas by its sensitivity to frost. *T. semipilosum* is apparently more drought resistant than *T. repens*, but is also sensitive to severe frost. *T. pratense* seems to be more promising than was previously realised.

CULTIVATED PASTURE

• *Nutrition*

T.5413/05/1/5: GROWTH AND CHEMICAL COMPOSITION OF DIFFERENT LEGUMES UNDER ACID SOIL CONDITIONS. 1985-1987

W.J. Fölscher

The growth of different legume species on two acid top soils was studied in the glasshouse at a low level of Ca, supplied as either hydroxide or sulphate. The hydroxide treatments, which raised the pH slightly, gave the better results, indicating that abnormal growth was associated with insufficient neutralisation.

There were large differences in growth performance of different species of legumes under the same Ca treatments and possible nutrient imbalances are discussed in terms of comprehensive plant analyses. Where growth was poor, lowered Mo and Ca uptake were apparent, although no definite pattern relating to any "metal toxicities" was discernible. Nitrogen nutrition was also abnormal, indicating possible problems with the level of N_2 fixation in certain treatments.

Furthermore it was clear that those species that showed reasonable resistance to acid soil conditions did not produce anything comparable to the level that could be obtained by neutralisation.

CULTIVATED PASTURE

• *Crop science*

D.5413/30/2/1: CULTIVATED PASTURE: SEEDING RATE AND WEED CONTROL IN THE ESTABLISHMENT OF RHODES GRASS. 1983-1985

T. Daines, R.A. Ingpen, E. Oosthuysen and C.J.G. le Roux

As the seeding rates recommended for Rhodes grass vary widely, a trial was conducted to study the effect of seeding rate, weed control measures and cutting on the establishment and yield of a Rhodes grass pasture. The trial was conducted at the Bathurst Research Station and was sown twice to eliminate seasonal effects.

The factorial combinations of seeding rate (3 kg, 6 kg, 12 kg or 24 kg/ha), weed control (nil, mowing, 4 ℓ/ha of 2,4-D amine or hand weeding) and of cutting (late boot stage or end of season) were used. Counts were made of the mother plants and daughter plants and the Rhodes grass canopy was estimated a year after seeding. Subsequently, the experiments were harvested a number of times.

Seeding rate, weed control and cutting all had significant effects on the tallies of mother plants. The tally of daughter plants in a plot was affected significantly by the weed control method only. Weed control also seemed to affect the canopy a year after seeding.

The first experiment in the trial showed that seeding rate, weed control and cutting each had a significant effect on the yield. These effects were more important at the first harvest than at the subsequent harvests. In the second experiment of the trial the effects of seeding rate, weed control and cutting seemed to endure longer than in the first experiment. This seems to be due to the fact that, in the first case, the Rhodes grass could colonise the plots fully more rapidly than in the second case, owing to the higher rainfall in the first case.

Because of the relatively small improvement in yield over the duration of a pasture's life-span owing to high seeding rates, it does not seem economically sound to use seeding rates higher than 3 kg/ha. However, as weed control is a less expensive item, it seems economical. The use of selective herbicides or mowing does seem advisable.

• *Crop science*

H.5413/30/1/3: CULTIVATED PASTURES: THE EVALUATION OF DIFFERENT *DIGITARIA* SPECIES IN THE HIGHVELD REGION. 1980-1986

C.S. Dannhauser, R.H. Drewes and G.F. Rautenbach

During November 1979 102 different selections of *Digitaria* spp. were established in plots (2 m x 5 m) at Potchefstroom. The object was to evaluate the different selections in terms of their dry matter production, germination of their seed, relative preferences by animals, as well as their rust and cold tolerance. Two replicates of each selection were established. On one replicate dry matter production, cold and rust tolerance and germination of the seed were evaluated. The other replicate was fenced in and grazed as foggage by sheep and cattle.

On the basis of the dry matter yield, the germination and the relative preference by animals, eight of the best selections were identified, and on request, made available to the Botany Department of the University of Pretoria for further investigations on seed production.

The results, obtained during 1979/80 and 1980/81, on the eight selections are given in Table 1. According to the results the highest germination was obtained from the seed of selections 45, 69 and 102. Selections 14 and 102 were prefered by the animals, whereas the highest production was obtained from selections 14, 17, 40 and 44.

TABLE 1 - The germination (%), preference intake and dry matter production of the different *Digitaria* selection

Type	Potch no.	Origin	Germination (%)		Preference* index		DM Production (t/ha)	
			79/80	80/81	78/80	80/81	79/80	80/81
Tufted	40	Estcourt 4	0	23,5	1,2	2,9	10,0	21,1
	44	Estcourt 2	0	20,0	2,5	2,9	10,0	17,5
	45	Estcourt 1	12,0	26,0	2,1	2,9	7,6	14,4
	69	Cedara 40	9,0	61,5	2,9	4,8	5,9	8,7
	102	Cedara 102	6,0	56,0	5,8	5,7	1,3	6,0
Stoloni-ferous	14	Nooitgedacht 27	0	0	10,0	5,7	14,2	15,1
	17	Nooitgedacht 57	12,0	0	2,3	2,8	15,9	19,7
	49	Nooitgedacht 58	14,0	2,0	2,3	2,8	6,0	13,2

*Preference index : rated from 1 (poor) to 10 (good)

• *Management*

D.5413/41/1/3: CULTIVATED PASTURE: GROWTH AND PRODUCTION OF SUMMER GRASSES IN THE EASTERN COASTAL REGION OF THE EASTERN CAPE. 1980-1985

L.O. Nel

A cutting trial on six different summer grass species was carried out in the eastern coastal region of the Eastern Cape to determine their growth patterns. The grasses were harvested at 30-, 60- and 90-day intervals.

The mean yields of the grasses cut at 30-, 60- and 90-day intervals were 10 tons, 12 tons and 13 tons per ha. This trend of increased yield with longer harvesting intervals occurred with all the grasses.

Results show that summer sub-tropical grasses can be successfully grown in the eastern coastal area. Sabi panic produced 14 388 kg DM/ha followed by Rhodes grass (13 070 kg/ha), Smuts finger grass (11 754 kg/ha), Coast cross II (11 463 kg/ha), kikuyu (10 501 kg/ha) and Stargrass (10 226 kg/ha).

• *Management*

D.5413/41/1/11: CULTIVATED PASTURE: SCREENING OF ANNUAL TEMPERATE LEGUMES AT DOHNE. 1980-1986

C.J.G. le Roux and L.G. Howe

In an investigation of low cost pastures, fifteen annual temperate legumes were evaluated in respect of total production, seasonal spread of production and their seed production. The comparisons took place at two sites in the Dohne sourveld.

The first site, Dohne Research Station, has a mild but relatively dry winter and a mean annual rainfall of 743 mm. The second site was the farm Grasslands in the Cathcart district. This site has a colder winter and an average rainfall of 866 mm per year.

The legumes involved in the trial were: *Vicia sativa, V. atropurpurea, V. villosa, V. dasycarpa, Ornithropus sativus, Ornithropus compressus* cv. Pitman, *Trifolium hirtum, T. vesiculosum* cv. Amclo, four *T. subterraneum* cultivars, i.e. Geraldton, Daliak, Woogenellup and Clare, *Medicago truncatula* cv. Hannaford, *Lotus hispidus* and *Lathyrus sativus*. The experimental design used was a randomised block layout and there were three replications. The plots all received a standard fertiliser application and were harvested at regular intervals. Seed production was determined once only at each site by collecting the seed lying on the ground in a small area of the plot.

At Dohne, the mean herbage yield over five seasons of the highest yielding cultivars (*Trifolium vesiculosum* cv. Amclo, *Vicia atropurpurea, V. dasycarpa* and *Ornithropus sativus*) were between 2 t/ha and 2,9 t/ha. This is about the same as that of natural veld (2,2 t/ha). The seasonal production at both sites was very erratic and growth curves could not be determined with any degree of reliability. Under these conditions annual cool season legumes do not seem to have an important role to play in a fodder budget. Seed production of some of the legumes in a good season was between 1 t/ha and 3 t/ha which suggests that seed production could be a lucrative enterprise.

At Grasslands the mean herbage yields (over four seasons) of the highest yielding cultivars (*Vicia villosa, V. dasycarpa*) was above 7 t/ha, and this compares favourably with that of natural veld. The more hardy legumes could play a role in a planned fodder budget. Monthly production figures of some of the legumes were determined but these are not very reliable. The seed yields at Grasslands during a good season were low due to predation by birds, but in some cases were between 1,9 t/ha and 2,7 t/ha. These values are also high enough to suggest that seed production could be a lucrative enterprise.

High herbage yields (between 10 t/ha and 15 t/ha) were obtained in a wet season. This suggests that some of the annual cool season legumes could be used in a forage budget under irrigation instead of irrigated rye grass pastures.

• *Management*

T.5413/41/2/1: CULTIVATED PASTURE: A COMPARISON OF GRAZING/FODDER TYPES AND THEIR COMBINATIONS FOR ANIMAL PRODUCTION BY MEANS OF STEERS IN THE SUMMER RAIN CROPPING AREA. 1981-1984

J.O. Grünow

A fodder flow/animal experiment, 40,8 ha in extent (7,5 ha irrigated), divided into 19 paddocks, was carried out over a two-and-a-half-year period.

The aims were firstly to compare fodder crops within seasons, and fodder flows over three seasons (winter/spring/summer), by means of pasture and animal parameters; secondly, to make economic comparisons between different fodder flows, for growing out beef steers.

The main conclusions were:

1. *Digitaria eriantha* ssp. *eriantha* is superior to *Eragrostis curvula* cv. Ermelo for animal production.

2. Maize residue gives economically favourable results because of low costs and compensatory growth of cattle on follow-up fodder.
3. An irrigated pasture (tall fescue) provides fodder in more than one season of a flow, for example, *Festuca* foggage/*Festuca* pasture/*Digitaria* dryland pasture, gives a very profitable fodder flow, because the costs of production of the irrigated pastures are divided between two seasons.
4. Dryland fodder flows with the sequence maize residue/maize silage or *Digitaria* hay/Digitaria pasture or, with silage or hay replacing the maize residue, were also very profitable.
5. The fodder flow giving the highest live mass gain per steer, is not necessarily the most economic.

CULTIVATED PASTURE

• *Chemistry*

N.5413/53/1/2: EFFECT OF NITRATE UPON THE DIGESTIBILITY OF KIKUYU GRASS (*PENNISETUM CLANDESTINUM*. 1978-1986

J.P. Marais (Ph.D.(Agric.) Univ. Natal) Supervisor: Dr. C. Dennison

In the high rainfall areas of Natal milk producers rely heavily upon kikuyu grass pastures during the summer months. The nutritive value of kikuyu grass is often lower than is expected. As high levels of nitrate are often present in this grass, attempts were made to establish the cause of these high nitrate levels and to study the effect of nitrate upon digestion in the ruminant.

The nitrate level of kikuyu grass was shown to be affected by the nitrogen level of the soil, the potassium level of the plant, the developmental stage of the plant and by climatic factors such as temperature, light and rainfall. The nitrogen and potassium levels of the soil seem to be major factors controlling nitrate levels in kikuyu grass. Furthermore, the morphology of the kikuyu plant allows constant exposure of high nitrate containing tissue to the grazing animal.

The presence of high levels of nitrate in kikuyu grass was shown to rduce digestion *in vitro*. The degree of reduction depends upon the level of nitrate in the plant, but is further modified by the presence of readily available carbohydrates and protein in the digest.

It was shown, by means of nitrate reductase enhibiting studies using tungstate, that the adverse effect of nitrite upon digestion, is due to the formation of nitrite by certain rumen microbes during the assimilatory reduction of nitrate to ammonia. Studies *in vivo* showed that the rumen microbial population of sheep can, to a certain degree, adapt by reducing nitrite and nitrate more rapidly, thus preventing nitrite from accumulating in the rumen under *ad lib*. feeding of fresh high nitrate (550% mg N) kikuyu grass. However, if the capacity of the nitrite reducers is exceeded by the introduction into the rumen of readily available forms of nitrate, nitrite accumulates. The increased level of nitrite has a deleterious effect upon the animal, both by suppressing digestion and by elevating levels of methaemoglobin in the blood.

Examination revealed that although nitrite reduces the digestion of cellulose, it has no direct effect upon the activity of rumen cellulases. The carbohydrases of the rumen digest are particle bound. Unsuccessful attempts were made to isolate these carbohydrases by means of gel filtration, PAGE and isoelectric focusing. Furthermore, the possibility of end product inhibition of cellulases was discounted as a possible cause of the observed decreased cellulose digestion *in vitro*.

Nitrite was shown to have a direct effect upon the rumen microbial population. In the presence of nitrite, cellulolytic, xylanolytic and total microbial numbers decrease with a concomitant decrease in cellulase and xylanase activity of the digest. The decrease in microbial numbers could not be attributed to an increase in the redox potential of the digest because of the oxidising nature of nitrite. Cellulolytic microbes are most sensitive to nitrite, but although the presence of nitrite changes the volatile fatty acid composition of the digest, the reduction in cellulolytic microbes was shown not to be the result of a lack of essential branched chain fatty acids required for cellulolytic microbial growth.

A study of the effect of nitrite upon pure cultures of rumen bacteria revealed the extreme sensitivity of some of the major cellulolytic microbes to nitrite. The growth of *Ruminococcus flavefaciens* strain FDI, *Butyrivibrio fibrisolvens* strain Ce51 and *Bacteroides succinogenes* strain S85, was severely inhibited in the range of 2 to 4 μg N cm^{-3}. In turn, *Ruminococcus albus* strain 22.08.6A and *Selenomonas ruminantium* strain ATCC 19205, a non-cellulolytic species, were only slightly affected by these nitrite levels. *Ruminococcus albus* and *Selenomonas ruminantium* obtain their energy from substrate-level processes only, while *Ruminococcus flavefaciens, Butyrivibrio fibrisolvens* and *Bacteriodes succinogenes* in addition obtain energy from electron transport mediated processes. Low levels of nitrate, therefore, seem to inhibit growth in these bacteria by affecting some vital part of the electron transport energy producing system. Higher

concentrations of nitrite seem to have a further general inhibiting effect upon rumen microbes, possibly by reacting with essential sulphydryl groups.

Nitrate affects digestion of kikuyu grass primarily through the action of nitrite upon energy producing electron transport processes in some key cellulolytic bacteria in the rumen. The extent of the effect upon digestion and animal production, however, depends upon the degree to which nitrite accumulates in the rumen and on the ability of the rumen microbial population to change towards a population containing an increased proportion of species capable of tolerating nitrite, especially those species which can also digest cellulose.

ANNUAL FODDER CROPS

• *Crop science*

LEGUME RESEARCH: A STUDY OF THE GROWTH OF FIVE *MEDICAGO* SPECIES IN THE CENTRAL GRASSVELD REGION AT GLEN. 1980-1983

L. Viljoen and H.J. Fouché

The aim of this study was to determine the adaptability of five annual *Medicago* genotypes (*viz. M. truncatula*: Cyprus; *M. truncatula*: Jemalong; *M. aculeata* enermis: SA 4438; *M. orbicularis*: SA 2552 and *M. rugosa*: Paragosa) to the central grassveld region. *Medicago* species have the advantage of fixating nitrogen from the air and providing pasture during the spring period when little other grazing is available.

Six sowing dates (from the middle of February until the end of April) were used. The effect of daylength, temperature and radiation on phytomass and seed production were also determined. Rainfall was regularly supplemented with irrigation to prevent moisture stress during growth, resulting in a total amount of 621 mm of water having been available.

The number of days between emergence and flowering and emergence and pod colouring, as well as frost resistance, were monitored. Total pod, seed and phytomass production were also determined. Of the early plantings, some seedlings were damaged by high air temperatures, while others were killed by frost in the late plantings. Paragosa appeared most susceptible to frost, whereas Enermis was undamaged and Cyprus only mildly affected.

Most genotypes began flowering after warm weather had set in after winter. The late sowings of Cyprus and Jemalong flowered until the middle of September. SA 2552 may be regarded as a fast grower, with Cyprus and Jemalong faster growers than Enermis.

Jemalong and Enermis had the highest production of phytomass at technically ripe stage. The mean production for the six sowing date treatments for Jemalong, Enermis, Cyprus, Paragosa and SA 2552 was 11,54; 10,72; 8,43; 6,68 and 5,04 ton/ha, respectively. Cyprus and SA 2552 yielded the highest pod mass at 5,77 and 5,71 ton/ha, respectively, whereas Paragosa yielded a mere 1,86 ton/ha. The middle of March is the best sowing time for obtaining a high pod yield.

Paragosa had the lowest crude protein content, probably as a result of the incorrect bacteria used as inoculant. SA 2552 had the highest crude protein content (27,91 %) followed by Enermis (21,92 %), Jemalong (21,88 %), Cyprus (21,98 %) and Paragosa (12,81 %). Paragosa was highly significantly more digestible than SA 2552, Jemalong and Cyprus.

Jemalong and Enermis would be the first choice regarding phytomass production, whereas SA 2552 is the outstanding genotype considering seed production and crude protein content. The best sowing time is during March.

LEGUME FODDER CROPS

• *Nutrition*

T.5417/05/1/1:

PRELIMINARY ASSESSMENT OF THE RESPONSES OF SELECTED PERENNIAL PASTURE LEGUMES TO THE APPLICATION OF LIMESTONE AND SUPERPHOSPHATE IN THE HIGH RAINFALL SOURVELD. 1983-1985

D.L. Barnes

Yield responses of crown vetch (*Coronilla varia*) cv. Penngift, lucerne (*Medicago sativa*) cv. CUF 101,

white clover (*Trifolium repens*) Dusi type and Kenya white clover (*T. semipilosum*) cv. Safari to differential application of lime and superphosphate, were determined in a 5 x 4 factorial experiment on a virgin soil of the Griffin form. Lime rates varied from 0 to 7 t/ha and phosphate rates from 0 to 150 kg P/ha. Patterns of response differed markedly between legumes. Clover yields were high even in the absence of lime and responses to differential lime rates were negligible.

By contrast, yields of crown vetch and lucerne where no lime was applied were very low, and yields increased markedly with successive increments of lime, the response of lucerne being greater than that of crown vetch. All the legumes responded to the application of phosphate, but yield increases decreased progressively with increasing phosphate level. Effects of the treatments on soil acidity and extractable nutrient elements were determined. A notable feature was an interactive effect between lime and phosphate on extractable phosphorus (0,25M $NaHCO_3$; pH 8,5). Values increased progressively with successive increments of phosphate application, but decreased with increasing lime application. Depressive effects of lime were greater at the higher than at the lower levels of phosphate.

In a separate experiment the pattern of yield response of birdfoot trefoil (*Lotus corniculatus*) cv. San Gabriel to soil amendment with lime and superphosphate on a virgin acid soil indicated that this legume is tolerant to local acid soils and moderately tolerant to low levels of extractable phosphorus.

RESOURCE UTILISATION RESEARCH (FARMING SYSTEMS)

Farming enterprises

MIXED FARMING

- *Situation analysis*

A SITUATION ANALYSIS OF MIXED FARMING IN THE STUTTERHEIM EXTENSION AREA. 1983-1986

P.G. King

A situation survey to determine the present production practices and yields of all aspects of farming in the Stutterheim Extension Ward was undertaken. The data obtained from this survey can be used as a benchmark for measuring change in any future extension programmes. The survey was undertaken by means of a personal questionnaire and 154 farmers or approximately 85 % of farmers whose farms are greater than 350 ha in extent were interviewed. The questionnaire dealt with matters relating to physical farm data, demography, veld management, cash and fodder cropping, livestock, soil conservation, labour, farmers' attitudes and farm economics.

The results of the survey are presented separately for the Stutterheim and Cathcart magisterial districts and refer specifically to the communities of Bolo, Quanti and Stutterheim and Upper Cathcart, Henderson and Thomas River in the two districts, respectively.

The factors limiting production are very similar in both the Stutterheim and Cathcart districts and as a result will be dealt with together. The Stutterheim Extension Ward is an extensive livestock producing area and the retrogression of the veld is considered to be the major factor limiting production.

The results show that the veld is over-stocked, continuous grazing is being practised, camps are too big, permanent stock drinking water is limited and that there is apparent confusion amongst farmers regarding which veld management system to apply.

Individually or together these factors can to a lesser or greater extent lead to the deterioration of the veld.

This has already occurred and is reflected in lambing and calving percentages which are below the desired levels, beef weaning masses which should be higher and low production of red meat per ha.

The reduction in profit margins are more than likely also related to the retrogression of the veld.

These problems can be overcome by undertaking extension programmes aimed at placing veld management practices on a sound footing.

Other matters which require attention are the high cattle mortalities which are possibly as a result of *Senecio* plant poisoning, the unrealistically long mating season for cattle in some communities, the large number of uncompleted farm plans, poor record keeping, the uncertainty amongst farmers regarding the use

of licks and the necessity of extension personnel to make regular contact, either directly or indirectly, with a greater number of farmers.

MIXED FARMING

• *Management*

D.5513/41/1/3: THE COMPILATION OF A MANUAL TO PROMOTE MIXED FARMING PRODUCTION TECHNIQUES IN THE PATERSON AREA. 1984-1985

P.G. King

A farming manual was drawn up to serve as a guideline to farmers in the Paterson area. Detail is given regarding the available resources as well as the enterprises which are adapted to the resources.

In the manual the production techniques for dairy, beef, sheep, wheat and pasture production are discussed. Economic aspects are also dealt with in detail.

MIXED FARMING

• *Management*

D.5513/41/1/5: THE COMPILATION OF A MANUAL TO PROMOTE MIXED FARMING PRODUCTION TECHNIQUES IN THE UITENHAGE VALLEY BUSHVELD AREAS. 1985-1986

P.G. King

The final report is drawn up in the form of a handbook for farmers and advisers. The resources available in the Uitenhage Valley Bushveld are described in detail. Enterprises which are adapted to these resources are listed and detail production techniques of each enterprise are outlined. Detail management guidelines are given for the veld which is the most important fodder source. Finally, an economic evaluation of the adapted enterprises is given.

The Uitenhage Valley Bushveld is situated north and north-west of Port Elizabeth and extends as far as the Sundays River in the east, the Suurberg Mountains in the north and the Groot Winterhoek mountains in the south-west. The vegetation consists of trees and scrub which is unique in that once it dissapears (by overgrazing or mechanically) it cannot be rehabilitated. The climate is arid with the rainfall varying between 250 and 350 mm/a. Temperatures are extreme reaching 44 °C in summer and -2 °C in winter.

Farming enterprises which are economially viable and adapted to the resources are Angora goats, Boer goats, game farming and to a lesser extent sheep. Detail production techniques are outlined for each of these enterprises. The natural veld forms the most important fodder source and detail veld management practices are given. Finally, an economic evaluation of the Angora goat enterprise is outlined.

MIXED FARMING

• *Management*

D.5513/41/2/1: THE DEVELOPMENT OF A MIXED FARMING PRODUCTION PLAN MODEL FOR THE DOHNE SOURVELD. 1984-1986

P.G. King

The integrated production plan is drawn up for a specific farm in reasonably homogenous farming area 4.1c. The document outlines the assessment of the resources, the determination of land capability classes, the present land use and the proposed land use with specific reference to fodder production planning, financial planning and the implementation of the plan.

The farm is located in the Dohne Sourveld and on the transition between this veld type and the Eastern Province Thornveld. The average annual rainfall is 720 mm, the average veld condition score is

approximately 78 % and the farm has a good proportion (189 ha) of class II land.

The proposed land use is based on the potential of the natural resources together with the economic viability of the proposed enterprises. The proposed farming system is an extensive sheep/beef/Boer goat production system. The veld will act as the major fodder source and will be supplemented by kikuyu and lucerne pastures and by maize for both grain and silage.

The implementation of the plan is planned over five years and should be carried out on the basis of management by objectives.

Veld Management techniques, production techniques and livestock production techniques are outlined in detail. Estimated production norms are also given.

This document attempts to bring together all the disciplines which are involved in the development of an integrated production plan.

MIXED FARMING

• *Management*

D.5513/41/2/2: THE DEVELOPMENT OF A MIXED FARMING PRODUCTION PLAN FOR THE BATHURST AND GLAZENWOOD RESEARCH FARMS. 1985-1986

P.G. King

The production plan is drawn up in the form of a handbook to be used primarily by research and farm personnel as a source of reference for the planning of present and future research programmes.

The research farms are situated in the high potential coastal area south of Grahamstown on the transition between the summer and winter rainfall areas. Research is based on intensive and semi-intensive farming systems with the emphasis on the development of planted pastures. Agronomic research will concentrate on maize, chicory, small grain (wheat, oats and barley) and the development of a nursery containing 30 different crops.

Animal production research will concentrate on dairy animals, sheep production (fat lambs) and Angora and Boer goat production. All this research will be undertaken on planted pastures. The Pasture Production section will concentrate on tropical species, fertiliser trials, mixed grass/legume pastures, comparisons between high and low cost pastures, grazing management studies and the role of fodder crops in fodder flow planning.

Finally, the Farm Section will be responsible for providing a back-up service for research. This will be done by physical development of the property and by producing maize and lucerne for periods of shortfall and for storage as a fodder bank.

AGRICULTURAL PRODUCTION ECONOMY RESEARCH

Macro resource economy

STRUCTURAL STUDIES

• *Production economics*

PE.5612/48/3/1: FARMING EFFICIENCY COMPARISONS BETWEEN PART-TIME AND FULL-TIME FARMERS IN THE TRANSVAAL HIGHVELD. 1980-1985

M. Nel

Three groups of farmers in the Eastern Transvaal Highveld were compared with each other: part-time farmers with a motive eventually to become involved in full-time farming (Category I), persons who probably will permanently farm part-time (Category II) and full-time farmers (Category III).

Full-time farmers maintain the highest productivity and Category II farmers the lowest. There are signs of over-capitalisation among full-time and Category II farmers. Category I farmers can increase investment

profitably; this increase should largely be in the form of high quality land, and there are indications that some of these farmers operate on poorer soils.

Full-time farmers operate on the largest farms, and Category II farmers on the smallest. There are indications that part-time farmers expend proportionally too little on intermediate inputs. Physical yields per hectare show little difference among the three groups of farmers and the only significant difference in gross margin per hectare of maize occurs between the two groups of part-time farmers. Productivity in dairying is generally low and Category II farmers fare the worst. Full-time farmers keep by far the most sheep, and Category II farmers the fewest. Full-time and Category I farmers obtain higher margins per wool-mutton sheep than part-time farmers.

The general impression is that Category I farmers deserve encouragement. They can eventually become productive full-time farmers.

Farm business management

BUSINESS RESULTS

• *Production economics*

PE.5621/48/3/4: BUSINESS RESULTS AND PRODUCTION COSTS OF ROOIBOS TEA IN THE WESTERN CAPE. 1986-1987

C.H. Ferrandi

The following information regarding general farm management results in the Western Cape and the production cost of rooibos tea are enclosed. The sample size was 41 farming units.

1. Average results per farming unit
   - (a) Area and composition thereof
   - (b) Capital investment and composition thereof
   - (c) Gross income
   - (d) Indirectly allocatable costs
     - (i) Fixed costs
     - (ii) Variable costs
   - (e) Directly allocatable costs
     - (i) Crops
     - (ii) Livestock
   - (f) Financial standards of comparison
2. Production cost of rooibos tea

ENTERPRISE RELATIONSHIPS

• *Production economics*

PE.5623/48/2/4: AN ECONOMIC EVALUATION OF SOME CROP ROTATION SYSTEMS UNDER DRYLAND CONDITIONS IN THE CENTRAL FREE STATE. 1983-1985

J.A. Grobler

The long-term profitability of six different systems of crop rotation and/or fallowing was determined using yield data over a period of 24 years. Yields were determined by means of PUTU crop growth models. Assessment of profitability was based on the analysis of farming profitability for a hypothetical farming unit for each of the systems.

The risk associated with each of the farming systems, in terms of the probability of not being able to

meet the fixed obligations of the farming unit in a specific year, was also determined. Of the systems tested, a long-fallow wheat system gave the highest profitability and held the lowest risk.

SOIL CONSERVATION RESEARCH

Soil conservation

EROSION

- *Conservation studies*

D.5711/38/3/1: DETERMINING METHODS OF RE-ESTABLISHING BARE HARD AREAS WITH VEGETATION IN THE TARKASTAD MAGISTERIAL DISTRICT.
1982-1987
J.E. Aspinall

Trials were laid out on the farm Carrickmoor during October 1982 to determine suitable methods of establishing bare hard areas with vegetation.

Different depths of subsoiling, namely 200, 300 and 400-450 mm and also different species of grasses and bush were tested out.

Trial plots were totally withdrawn from grazing for 34 months and thereafter grazed with cattle for a short while during winter.

The rainfall was very intermittent and below average. Drought periods occurred from time to time.

The following results were obtained:

(i) Subsoiling should be done at least 400 mm deep at intervals of 2 m apart.
(ii) Sowing of one of the following species or a mixture thereof namely Smuts finger grass, Rhodes grass, *Eragrostis curvula* and creeping salt bush is recommended.
(iii) Grass seed must only be sown after good rain has fallen on the subsoiled areas.
(iv) Agriculture gypsum must be added to the soil where necessary according to soil analysis.
(v) Areas under treatment must be withdrawn from grazing for at least 3 years.
(vi) *Themeda triandra* ("rooi gras") must be sown in annually during the 3-year period of withdrawal.
(vii) Columbus grass, which grows easily on any poor soil type, can be sown and must be cut down with a mower or bush-cutter and material left on the soil to create a mulch and seed bed for seedlings.

ENTREPRENEUR DEVELOPMENT

EXTENSION SCIENCE INVESTIGATIONS

Resources and technology

MANAGEMENT FACTORS

• *Persuasion*

T.6114/39/1/3: THE PERSUASION OF FARMERS TO OPTIMAL RESOURCE UTILISATION IN THE LOWVELD OF THE TRANSVAAL REGION (AVOCADO FARMERS - LETABA AREA). 1978-1983.

I.J. van Rensburg

Apart from the above-mentioned long-term objective, i.e. persuasion of farmers to optimal resource utilisation, the project had the following short-term goals which were largely achieved:

(a) To make a study of avocado production in the Letaba area by means of the Tzaneen Avocado Study Group and to apply the knowledge gained to the advantage of the avocado industry.
(b) To assist at least ten beginner avocado farmers with the planning of their avocado orchards anually.
(c) As determined by the time available and according to the requests recieved to pay as many visits as possible to farmers with specific avocado production problems (i.e. pest control, irrigation, fertilisation, etc).
(d) To disseminate information by the use of mass media - i.e. farmers days, agricultural weeklies, "Calling all farmers", leaflets, local newspapers, etc.
(e) When necessary to assist with the census survey of all avocado producers in the Letaba area.

A very broad spectrum of avocado production problems were attended to. These included the rootrot problem (*Phytophthora cinnamoni*), fertilisation, pest and disease control, nursery practices, etc.

The main thrust of the effort was, however, to try and reduce the incidence of rootrot in avocado orchards and only this one aspect is reported on so as not to make this report to lengthy.

In 1978 and in the years prior to this, rootrot was a serious problem in orchards, causing a considerable loss in production and the premature death of many trees. A survey indicated that 83 % of all avocado orchards were to some extent affected by this disease. Many factors influence the occurrence of this disease but attention was mainly focussed on the following:

(a) *Chemical control*

The use of the chemical compounds metaloxyl and later Fosatyl-al was widely propagated and these compounds were used and tested on study group members' farms, even before they were registered. Demonstration plots were used, and in all cases the positive results achieved acted as a spur to surrounding farmers to make use of these methods.

(b) *Suitable soil*

Farmers were encouraged to avoid planting avocados on poorly drained and otherwise unsuitable soil by means of individual visits to farms, demonstration orchards and mini-farmers days. A total of 15 mini-farmers days were held during the five-year period.

(c) *Healthy nursery trees*

At all possible occasions farmers were motivated to buy only healthy and disease-free nursery trees on rootrot resistant rootstocks from registered nurseries.

Rootrot is not the dreaded disease it used to be in the late seventies and early eighties and it is stated that the above programme played its part in reducing the incidence of the disease to less than 15 % of the avocado trees in the area.

• *Extension science*

D.6115/40/1/1: THE CHARACTERISTICS AND ROLE OF OPINION LEADERS IN THE STUTTERHEIM EXTENSION WARD. 1983-1985

P.G. King

Data for this study were collected by personally interviewing 153 farmers in the Stutterheim Extension Ward. Opinion leadership was investigated by means of a sociometric survey. Additional data regarding the physical development of the farm, veld management systems, crop and livestock production techniques and yield norms, factors relating to soil conservation, labour attitudes, managerial aptitude and finance were collected.

The objectives of the study are to describe the physical and sociological aspects of the study area; to identify opinion leaders; to determine their geographic situation, characteristics and progressiveness, and to make suggestions regarding the role of opinion leaders in improving communication in extension.

The study area is a semi-extensive livestock producing area with less than 10 % of the total area cultivated. The age distribution of the farmers is negatively skewed which augurs well for future extension programmes as younger farmers are more likely to accept change. The study showed that 19 % of farmers have post-matriculation formal agricultural training.

Forty-eight per cent of farmers attended one to three farmers days, study tours or lectures annually while 51 % were never visited by Departmental extension personnel on their farms.

Farmers who received three or more nominations per sociometric item were considered to be opinion leaders. These nominated opinion leaders were well distributed throughout the study area and the majority of interactions for all sociometric items occurred within farmer community boundaries. This suggests that extension programmes should be developed specifically for each community.

Interactions in the study area were found to be predominantly homophilous while opinion leadership was found to be monomorphic.

An independent survey was undertaken amongst the 21 identified opinion leaders to determine their most important sources of information. Fellow farmers were shown to be the farmer's most reliable sources of information. The extension service of the Department of Agriculture was never mentioned as a source of information; the Dohne Agricultural Research Station was mentioned, but was not considered as an important source of information. The observation was made that opinion leaders appear to attach more importance to the extension officer than the institution which he represents.

Opinion leaders have a key role to play in the diffusion and adoption of improved farming practices. Extension officers must make use of opinion leaders to form the nucleus of permanent audiences. Opinion leaders have an important role to play in the evaluation trial and adoption stages of the adoption process and extension officers can exploit this situation by directly involving them in farmers days, demonstrations and discussion groups.

• *Extension science*

H.6115/40/1/1: MAN: THE ADOPTION PATTERN OF STUBBLE MULCH PRACTICES BY MAIZE FARMERS IN THE BOTHAVILLE EXTENSION WARD. 1985-1986

G.P. van Wyk

Keeping in mind the value of stubble mulching, one would expect a much more ready acceptance of this practice among farmers than is the case at present. Because becoming aware of stubble mulching essentially take place through communication in the widest sense of the word, it is only logical in this regard that an investigation will start with the first step in this process of communication.

The suspicion that an ineffectual message with regard to stubble mulching among the relevant agriculturists (as caused by differential perception) is an obstacle in the way of acceptance, was confirmed by the identification of a wide dispersion of opinion regarding practically all facets of stubble mulching.

• *Extension science*

T.6115/40/1/1: THE INFLUENCE OF GROUP DYNAMICS ON THE FUNCTIONING OF STUDY GROUPS. 1983-1987

S.E. Terblanche

The aim of this study was to assess the internal and external dynamic forces and to consequently determine their relationship with group efficiency.

Data for the study was obtained by means of a questionnaire which was completed by 68 respondents from seven study groups in the Pietersburg and Louis Trichardt Extension Wards.

An IBM computer was used to analyse the data. Essentially arithmetic means, frequency distributions, chi-squares, Spearman's coefficients of rank correlation, log linear analysis and analysis of variance were used to determine the correlation between the different variables and group efficiency and the relationship between the respective categories of efficiency.

In order to establish a criterion for group efficiency the seven study groups were subjectively rated according to group efficiency, namely low, average and high.

Highly significant correlation were found with respect to a number of internal and external dynamic forces. The more efficient groups are therefore characterised by the following:

- There is mutual co-operation among the study group members (psychological atmosphere).
- Higher percentage of group members do more than what is expected of them (participation).
- They are more convinced about the effect of social intercourse, during or after a study group meeting, having a strengthening influence on group maintenance (group standards).
- "We feeling" within the study group is stronger (cohesiveness).
- The presence of a written constitution strengthen the "we feeling" (cohesiveness).
- They prefer and recommended a smaller group size.
- They make less use of a subject specialist to address the group (techniques).
- They make more use of farmers who are not members of the study group, to address the group (techniques).
- Considerable more tasks are delegated to group members (techniques).
- Suggested evaluation methods are more specific and clear (evaluation).
- Currently considerable more time is sacrificed for study group activities (multiple group membership).
- They are willing to sacrifice considerable more additional time for study group activities (multiple group membership).

The higher the group efficiency the stronger the effect of the abovementioned aspects and thus the greater the differences between the more and less efficient group.

The results also showed a significant correlation between group efficiency and a number of the following internal and external dynamic forces:

- Meetings take place at different locations (physical atmosphere).
- Members help each other to feel part of the group (psychological atmosphere).
- A higher percentage of group members attend meetings regularly (participation).
- Groups prefer a constitution which is an absolute regulation (group standards).
- Group members are more aware of the constitution (group standards).
- Group members are to a greater extent aware of the role each member has to fulfill in the group (general role definition).
- A significantly smaller maximum group size is recommended (size).
- Groups are more task-orientated (leadership).
- The delegation of tasks to group members has a definite effect on improving their knowledge (techniques).
- Group members are to a greater extent aware of existing methods to evaluate group work (evaluation).
- Existing methods of evaluation occur more thoroughly (evaluation) and there is a greater need for integrating the study group with the district agricultural union (parent organisation).

Even where the correlation between group efficiency and aspects of the internal dynamic forces such as communication patterns, heterogeneity/homogeneity and group objective were not significant, there is a tendency for the more efficient groups to rate these aspects higher than groups in the less efficient categories.

In spite of limited differences between the respective study groups in terms of efficiency the results confirmed the fact that the functioning of groups is influenced by their internal and external dynamic forces. The consequence with which this occurs point to a close interdependence between the different internal and external dynamic forces. This suggests that already a limited amount of proper group techniques can contribute to the efficient functioning of groups.

PROGRAMMED EXTENSION

Resource utilisation

CROP FARMING

• *Persuasion*

K.6212/39/1/1: CROP FARMING: PROMOTION OF DURUM WHEAT CULTIVATION IN THE FISH RIVER VALLEY, CRADOCK EXTENSION WARD. 1979-1985

P.S. van Heerden

The phasing out of bread wheat cultivars suitable for the making of pasta products led to the importation of large quantities of durum wheat. To reduce importation, an objective was set to produce 10 000 tons of durum wheat locally. To reach this goal, a persuasion programme for farmers had to be launched.

The Great Fish River Valley, with Cradock near its centre, was proclaimed as a production area for durum wheat. Within this area, 23 230 hectare are scheduled as irrigation ground. Orange River water is supplied through the Orange-Fish River tunnel.

The irrigation area is mainly a lucerne production area, with maize, wheat and pastures being the next most important crops.

The persuasion programme that was adopted resembled the programme described by Burger and Düvel (1973) to a large extent. Main programme steps were: consideration, investigation, preparation, execution and evaluation. Results were as follows:

Area

The planted area increased rapidly up to the 1983/84 season, when 80,6 % of the goal of 2 000 hectares was attained. Since 1983/84 the planted area decreased very rapidly. During the 1982/83 season, the number of growers reached a maximum of 63. The number of growers decreased rapidly since then.

A distincentive for the adoption of durum wheat cultivation that became very noticeable since 1982/83 was the relatively low income generated by wheat production, compared to income generated by lucerne and maize production.

Yield

Yield did not follow the pattern set by predetermined goals. A possible explanation could be a lower average production by later adopters, after the cessation of production by innovators and early adopters. Production techniques, such as irrigation management, fertilisation and weed control, are also on a lower level for later adopters than for earlier adopters. Maximum average yield was 3,5 tons per hectare, compared to the final goal of 5 tons per hectare.

Total production

Total production increased to 3 773 tons during the 1982/1983 production year, when 47,9 % of the short-term goal was attained. This represented 37,7 % of the final target production. Since 1982/1983, production decreased to such an extent that production during the 1984/1985 production year represented only 23,4 % of target production.

AGRICULTURAL ENGINEERING SERVICES

Mechanisation

POWER SOURCES AND LABOUR

• *Engineering*

LI.6711|51|1|3: POWER SOURCES AND LABOUR: PERFORMANCE OF TRACTOR THREE-POINT HITCH SYSTEMS UNDER SOUTH AFRICAN CONDITIONS. 1981.

A.J. Heyns

The aim of the investigation was to determine the influence of the three-point hitch geometry on the implement and to investigate the performance of a typical draught control system. A literature study and a computer simulation have shown that the geometry and specifically the position of the virtual hitch point can influence the penetration, stability and self-steering characteristics of an implement.

Field measurements of draught and working depth have brought to light that the draught control system effectively controls both draught and working depth. It was found that the control system characteristics such as dead band and delay time are not compatible with the engine and torque characteristics of the tractor. The engine may stall or the drive wheels may loose traction before the draught control system reacts.

SCIENTIFIC ARTICLES
WETENSKAPLIKE ARTIKELS

PLANT PRODUCTION PROMOTION
PLANTPRODUKSIEBEVORDERING

AGRONOMY RESEARCH/AKKERBOUNAVORSING

Summer grain/Somergraan

MAIZE/MIELIES

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• *Upgrading/Veredeling*

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• *Pests/Plae*

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GRAIN SORGHUM/GRAANSORGHUM

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WHEAT/KORING

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• *Soil science/Grondkunde*

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• *Technology/Tegnologie*

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• *Technology/Tegnologie*

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COTTON/KATOEN

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- *Crop science/Gewaskunde*

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TOXIC SUBSTANCES/TOKSIESE STOWWE

- *Virology/Virologie*

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- *Pathology/Patologie*

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INFERTILITY/ONVRUGBAARHEID

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EXTERNAL PARASITES/EKSTERNE PARASIETE

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• *Production economics/Produksie-ekonomie*

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WHEAT/KORING

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DURUM

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- *Nutrition/Voeding*

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BANANA/PIESANG

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Ruminants/Herkouers

LARGE STOCK/GROOTVEE

- *Reproduction/Reproduksie*

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Nutrition/Voeding

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Pasture/Weiding

VELD

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• *Nutrition/Voeding*

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RESOURCE UTILISATION RESEARCH (FARMING SYSTEMS) HULPBRONBENUTTINGSNAVORSING (BOERDERYSTELSELS)

Farming enterprises/Boerderyvertakkings

STOCK FARMING/VEEBOERDERY

• *Nutrition/Voeding*

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LANDBOUMEGANISASIE

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NATURAL RESOURCES/NATUURLIKE HULPBRONNE

- *Extension science/Voorligtingkunde*

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LANDBOU-INGENIEURSDIENSTE

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Agricultural structures and facilities
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- *Situation analysis/Situasiebepaling*

GG.2111/35/1/1: The monitoring of fertilisation, tillage, weed control and pest control practices in maize production. 1986. C.H. Heenop

Modelling/Modellering

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GRAIN SORGHUM/GRAANSORGHUM

Physiology/Fisiologie

GG.2112/03/1/1: A physiological investigation of grain sorghum lines under moisture stress conditions. 1985. A.J. Pretorius

• *Upgrading/Veredeling*

GG.2112/07/1/1: Breeding for general disease resistance in grain sorghum. 1986. N.W. McClaren

GG.2112/07/2/1: Development of grain sorghum lines with improved yield and quality for human and animal use. 1983. W.G. Wenzel

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• *Pathology/Patologie*

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• *Pests/Plae*

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• *Chemistry/Chemie*

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BUCKWHEAT/BOKWIET

• *Crop science/Gewaskunde*

GG.2113/30/1/1: Evaluation of buckwheat cultivars for agricultural industrial value and adaptability. 1974. A.J. Pretorius

WHEAT/KORING

• *Physiology/Fisiologie*

GG.2121/03/1/1: Determination of the temperature requirement of wheat. 1982. G.D. Joubert

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GG.2121/03/1/6: Determination of coleoptile length and related aspects of wheat. 1983. G.D. Joubert

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GG.2121/19/1/1: Occurrence and distribution of root-and-foot-rot disease in wheat. 1978. B. de Scott

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GG.2121/19/1/5: Chemical control of root disease in wheat. 1982. E.M. Smith

GG.2121/19/2/1: Observations on the occurrence of air-borne diseases of wheat in South Africa. 1980. Z.A. Pretorius

GG.2121/19/2/2: Collection, maintenance and classification of wheat stem rust biotypes (*Puccinia graminis* f. sp *tritici*). 1980. J. le Roux

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- *Crop science/Gewaskunde*

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- *Chemistry/Chemie*

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TRITICALE

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GG.2122/07/1/1: The evaluation of elite newly developed and introduced cultivars. 1976. C. Bothma

GG.2122/07/2/1: The selection of meiotic stable breeding parents from advanced triticale lines. 1976. H.A. van Niekerk

GG.2122/07/3/1: The evaluation of triticale germ plasm. 1981. I.B.J. Smit

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GG.2122/07/3/3: The development of a computerised database for unique triticale germ plasm. 1983. M.T. Aartsma

DURUM

- *Nutrition/Voeding*

GG.2123/05/1/1: Effect of nitrogen fertilisation on the production and quality of durum wheat under irrigation. 1982. W.H. Kilian

- *Upgrading/Veredeling*

GG.2123/07/1/1: The evaluation of elite newly developed and imported durum lines. 1976. H.A. van Niekerk

GG.2123/07/2/1: The evaluation of durum germ plasm. 1981. I.B.J. Smit

GG.2123/07/2/2: The upkeep of unique durum germ plasm. 1981. M.T. Aartsma

GG.2123/07/2/3: The development of a computerised database for durum production. 1983. M.T. Aartsma

GG.2123/07/3/1: The quality evaluation of all newly developed durum lines. 1976. H.A. van Niekerk

BARLEY/GARS

- *Physiology/Fisiologie*

GG.2124/03/1/1: Determination of factors which cause black-end coloration to barley in the winter rainfall area. 1982. E.J.G. Brand

- *Upgrading/Veredeling*

GG.2124/07/1/1: The breeding of barley and evaluation of elite newly developed and imported cultivars. 1976. P.B. le Grange

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- *Crop science/Gewaskunde*

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GG.2124/30/3/2: Phytotoxicity of wild oat herbicides on barley in the winter rainfall area. 1982. H.A. Smit

GG.2124/30/3/3: Phytotoxicity of herbicides on promising barley lines and new barley cultivars in the summer rainfall area. 1982. H.A. Smit

GG.2124/30/3/4: The determination of the apex development stages of barley for the safe application of hormone type herbicides in the summer rainfall area. 1982. H.A. Smit

RYE/ROG

- *Upgrading/Veredeling*

GG.2125/07/1/1: The evaluation of elite newly bred and imported rye lines. 1976. H.A. van Niekerk

GG.2125/07/2/1: The evaluation of germ plasm. 1981. I.B.J. Smit

GG.2125/07/2/2: The upkeep of unique rye germ plasm. 1981. M.T. Aartsma

GG.2125/07/2/3: The development of a computerised database for unique rye germ plasm. 1983. M.T. Aartsma

OATS/HAWER

- *Upgrading/Veredeling*

GG.2126/07/1/1: The evaluation of elite newly developed oat lines and introductions. 1976. M.T. Aartsma

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• *Crop science/Gewaskunde*

GG.2126/30/1/1: The multiplication of elite oat lines in the winter rainfall area. 1982. E.J.G. Brand

GG.2126/30/1/2: Seed multiplication of elite oat lines in the summer rainfall area. 1982. G.D. Joubert

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Protein and oil seeds/Proteïen- en oliesade

GROUNDNUTS/GRONDBONE

• *Physiology/Fisiologie*

GG.2131/03/1/1: Groundnuts: partitioning analysis. 1981. J. Dreyer

GG.2131/03/2/1: The influence of varying temperatures on the gynophore and pod set of groundnuts. 1983. J. Dreyer

GG.2131/03/3/1: Drying characteristics of groundnuts. 1983. C.J. Swanevelder

• *Nutrition/Voeding*

GG.2131/05/1/1: NPK fertiliser studies with groundnuts. 1983. H.L. Loubser

GG.2131/05/1/2: The influence of boron and calcium fertilisation on mould contamination of groundnuts. 1984. C.J. Swanevelder

GG.2131/05/1/3: Calcium fertilisation of groundnuts. 1985. C.J. Swanevelder

GG.2131/05/1/4: The influence of nitrogen fertilisation and daminozide on the production of runner type groundnuts. 1985. C.J. Swanevelder

GG.2131/05/1/5: Foliar application of seaweed extract on groundnuts. 1985. C.J. Swanevelder

• *Upgrading/Veredeling*

GG.2131/07/1/1: Evaluation of introductions and breeding parents of groundnuts. 1974. P.J.A. van der Merwe

GG.2131/07/1/2: The improvement of groundnuts for dryland conditions. 1974. P.J.A. van der Merwe

GG.2131/07/1/3: The improvement of groundnuts for irrigation areas. 1974. P.J.A. van der Merwe

GG.2131/07/1/5: Studying and development of anther culture techniques in aid of development of new groundnut cultivars. 1986. P.C.W. van der Walt

• *Pathology/Patologie*

GG.2131/19/1/1: Fusarium diseases of dryland cultivated groundnuts. 1985. S.H. Swart

GG.2131/19/2/1: *Macrophomina* infections on groundnuts. 1985. E.L. Holtzhausen

GG.2131/19/3/1: The influence of groundnut root and pod exudates on *Chalara elegans*. 1984. J.R. Anderson

GG.2131/19/3/2: The influence of groundnut rhizosphere micro-organisms in controlling/stimulating *Chalara elegans* infestation. 1984. J.R. Anderson

GG.2131/19/3/3: Interactions between *Chalara elegans* and saprophytic or ecto-parasitic nematodes in the dissemination of disease (black hull) on groundnuts. 1984. J.R. Anderson

GG.2131/19/3/4: Method of entry of *Chalara elegans* into groundnut tissue. 1984. J.R. Anderson

GG.2131/19/3/5: Development of reproducible and accurate method for enumerating spores of *Chalara elegans* in groundnuts, soils and plant debris. 1984. J.R. Anderson

GG.2131/19/3/6: Laboratory studies on the nutritional requirements and biochemical pathways of *Chalara elegans* as found on groundnuts. 1984. J.R. Anderson

GG.2131/19/3/7: Laboratory and greenhouse preliminary screens on groundnuts for biocides active against *Chalara elegans*. 1984. J.R. Anderson

GG.2131/19/3/8: Developing of laboratory-greenhouse method for testing groundnut genotypes for resistance to *Chalara elegans*. 1983. B.L. Jones

GG.2131/19/3/9: The use of crop rotations in controlling *Chalara elegans* in groundnuts. 1983. B.L. Jones

GG.2131/19/3/10: Survey of naturally occurring *Chalara elegans* in the groundnut production areas of the RSA. 1982. B.L. Jones

GG.2131/19/3/11: Biological control of *Chalara elegans* in groundnuts. 1982. J.R. Anderson

GG.2131/19/3/12: Pathogenicity studies with *Chalara elegans* of groundnuts. 1982. C.L.E. Labuschagne

GG.2131/19/3/13: To investigate the mode of *Chalara elegans* resistance in groundnuts. 1985. B.L. Jones

• *Pests/Plae*

GG.2131/20/1/1: *Hilda patruelis* and mould on groundnuts. 1984. C.J. Swanevelder

• *Crop science/Gewaskunde*

GG.2131/30/1/1: Groundnut cultivar evaluation in different production areas. 1977. C.J. Swanevelder

GG.2131/30/2/2: Ridge planting of groundnuts for limiting black hull. 1982. J. Dreyer

GG.2131/30/2/3: Harvesting techniques and mould contamination of groundnuts. 1985. C.J. Swanevelder

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GG.2131/30/2/5: Basin tillage in groundnut production. 1984. E.B. Birch

GG.2131/30/3/1: The influence of planting date on runner type groundnuts. 1985. C.J. Swanevelder

GG.2131/30/4/1: Determining the effect of nut grass, *Cyperus* spp. on the yield of groundnuts. 1982. A.P.J. de Beer

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SUNFLOWERS/SONNEBLOMME

• *Physiology/Fisiologie*

GG.2132/03/1/1: Study on effect of environmental factors on growth, development and yield of sunflower. 1982. R.N. de Vos

• *Nutrition/Voeding*

GG.2132/05/1/1: The nitrogen, phosphorus and potassium requirements of sunflowers. 1981. H.L. Loubser

GG.2132/05/1/2: The response of sunflowers to different rates of nitrogen and phosphorus as influenced by liming. 1981. H.L. Loubser

GG.2132/05/1/4: The effect of mycorrhiza on the utilisation of phosphorus by sunflowers. 1985. H.L. Loubser

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GG.2132/05/1/6: The effect of nitrogen, phosphorus and moisture levels on the nitrogen and phosphorus removal by different plant components. 1984. H.L. Loubser

• *Upgrading/Veredeling*

GG.2132/07/1/1: Introduction and evaluation of sunflower lines for use in a breeding programme. 1974. W.J. Vermeulen

GG.2132/07/1/2: The breeding of sunflower restorer lines and composites for utilisation in hybrid breeding. 1974. B.C. Greyling

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• *Pathology/Patologie*

GG.2132/19/1/1: *Macrophomina* infections of sunflower. 1985. E.L. Holtzhausen

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• *Pests/Plae*

GG.2132/20/1/1: The identification of the nematodes associated with sunflower. 1984. C. Bolton

GG.2132/20/1/2: The optimal environmental conditions predisposing the attack of the most important nematode species on sunflower. 1984. C. Bolton

• *Crop science/Gewaskunde*

GG.2132/30/1/1: Evaluation of sunflower cultivars in different production areas. 1978. H.L. Loubser

GG.2132/30/1/2: The ability of sunflower cultivars to compensate for low plant populations. 1983. H.L. Loubser

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GG.2132/30/1/4: Reaction of sunflower cultivars on varying levels of soil acidity. 1982. J. Chapman

GG.2132/30/1/5: Self-pollination and self-compatibility of sunflower cultivars. 1985. E.B. Birch

GG.2132/30/1/6: Tolerance of sunflower cultivars to Al toxicity. 1983. E.B. Birch

GG.2132/30/2/1: Basin tillage in sunflower production. 1984. E.B. Birch

GG.2132/30/2/2: Row spacing on basin tillage in sunflower production. 1985. E.B. Birch

GG.2132/30/2/3: Weed control for basin tillage in sunflower production. 1985. E.B. Birch

GG.2132/30/2/4: Infiltration rate of sunflower soils. 1985. E.B. Birch

GG.2132/30/2/5: Run-off on sunflower soils. 1985. E.B. Birch

GG.2132/30/2/6: Mulch period and level on sunflower production. 1985. E.B. Birch

GG.2132/30/2/7: Millet mulching in sunflower production. 1985. E.B. Birch

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• *Modelling/Modellering*

GG.2132/42/1/1: Predicting of the effect of nitrogen fertilisation and moisture supply on the yield of sunflowers. 1985. H.L. Loubser

SOYBEANS/SOJABONE

• *Physiology/Fisiologie*

GG.2133/03/1/1: The effect of planting date on the response of soybean cultivars at different plant populations. 1983. J. Chapman

GG.2133/03/1/2: Interaction between yield components and interplant competition of soybeans. 1985. M.A. Smit

• *Nutrition/Voeding*

GG.2133/05/1/1: The interaction of lime on nitrogen, phosphorus and potassium fertilisation on soybeans. 1983. J. Chapman

GG.2133/05/1/2: The determination of critical values for soil phosphorus with soybeans. 1983. J. Chapman

• *Upgrading/Veredeling*

GG.2133/07/1/1: Evaluation of soybean lines/introductions for use as commercial cultivars and/or as parents in a breeding programme. 1983. T.E.M. Odendaal

GG.2133/07/1/2: The selection and generation of segregating material. 1984. T.E.M. Odendaal

• *Crop science/Gewaskunde*

GG.2133/30/1/1: Evaluation of soybean cultivars in different production areas. 1978. J.N.H. Lemmer

GG.2133/30/1/3: Tolerance of soybean, sunflower and dry bean cultivars to Al toxicity. 1982. M.A. Smit

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GG.2133/30/1/5: Response of soybean cultivars to aluminium under field conditions. 1982. J. Chapman

GG.2133/30/2/1: Basin tillage in soybean production. 1984. E.B. Birch

DRY BEANS/DROëBONE

• *Nutrition/Voeding*

GG.2134/05/1/1: The effect of nitrogen application levels at different growth stages of dry beans. 1983. A.J. Liebenberg

• *Upgrading/Veredeling*

GG.2134/07/1/1: The evaluation of dry bean introductions. 1970. W.J. Vermeulen

GG.2134/07/1/2: The breeding of dry beans for canning purposes. 1970. W.J. Vermeulen

GG.2134/07/1/3: The breeding of dry beans for the packaging trade. 1983. B.R. Edington

• *Pathology/Patologie*

GG.2134/19/1/1: The production of disease-free dry bean (*Phaseolus vulgaris*) seed at Lutzville and Burgershall. 1977. A.J. Liebenberg

G.2134/19/1/2: The production of disease-free dry bean (*Phaseolus coccineus*) seed. 1984. A.J. Liebenberg

G.2134/19/1/3: Production of disease-free dry bean seeds via meristem and other *in vitro* culturing methods. 1985. P.C.W. van der Walt

G.2134/19/2/1: Survey of fungal diseases on dry bean roots in the summer rainfall regions of South Africa. 1985. S.H. Swart

G.2134/19/2/2: Survey of fungal diseases on the pods of dry beans in the summer rainfall regions of South Africa. 1985. S.H. Swart

G.2134/19/2/3: Survey of fungal diseases on dry bean leaves in the summer rainfall regions of South Africa. 1985. S.H. Swart

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GG.2134/30/1/2: The determination of the compensation ability of dry bean cultivars under varying plant densities. 1983. A.J. Liebenberg

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GG.2134/30/1/4: The evaluation of the International Bean Yield and Adaptation Nursery (IBYAN) of CIAT. 1983. A.J. Liebenberg

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GG.2134/30/1/8: Effect of herbicides on the growth and development of different dry bean (*Phaseolus vulgaris*) cultivars. 1983. A.P.J. de Beer

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GG.2134/30/2/1: The influence of planting date on dry bean cultivars under different soil moisture levels. 1983. A.J. Liebenberg

LUPINS/LUPIENE

• *Physiology/Fisiologie*

GG.2135/03/1/1: A study on the effect of daylength and temperature on the growth and development of *Lupinus albus, Lupinus mutabilis* and other lupin species. 1985. J.A.M. van der Mey

GG.2135/03/2/1: A survey on the occurrence of different alkaloids in lupin species and lines for the summer rainfall areas. 1985. J.A.M. van der Mey

GG.2135/03/2/2: Testing for seed coat hardness in lupin species and lines for the summer rainfall areas. 1985. J.A.M. van der Mey

• *Nutrition/Voeding*

GG.2135/05/1/1: The influence of fertiliser placement on germination, growth, development and seed yield of lupins. 1985. H.L. Loubser

GG.2135/05/1/2: The influence of soil and pH on the growth, development and yielding of lupins in the summer rainfall area. 1985. H.L. Loubser

GG.2135/05/1/3: Plant nutritional studies on lupins with macro-elements in the summer rainfall areas. 1985. H.L. Loubser

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• *Upgrading/Veredeling*

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• *Pathology/Patologie*

GG.2135/19/1/1: Survey of root diseases on lupins in the summer rainfall region of South Africa. 1985. D.E. Malan

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GG.2135/30/2/2: Determination of optimal population density of lupins for the different production areas in the summer rainfall regions. 1985. J.A.M. van der Mey

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GG.2135/30/3/2: Control of broad-leaf weeds in lupin plantings in the summer rainfall areas. 1985. A.P.J. de Beer

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OTHER SEEDS/ANDER SADE

• *Crop science/Gewaskunde*

GG.2136/30/1/1: Other seeds: introduction of cowpea breeding material. 1985. J.J. Coetzee

GG.2136/30/2/1: Other seeds: evaluation of bambara in different production areas. 1984. C.J. Swanevelder

Other agronomic crops/Ander akkerbougewasse

COTTON/KATOEN

Physiology/Fisiologie

K.2141/03/1/1: Investigation of possible causes of "rooidood" of cotton. 1983. N.J.J. Combrink

Nutrition/Voeding

K.2141/05/1/1: Response of cotton to nitrogen application with petiole analyses as diagnostic aid. 1980. M.C. Dippenaar

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K.2141/05/1/3: Influence of mutual relation among nutrient elements in the soil and in cotton plants on the yield potential. 1983. N.J.J. Combrink

Upgrading/Veredeling

K.2141/07/1/1: Cotton breeding and selection. 1974. A.I. Greeff

K.2141/07/1/2: Introduction of cotton-breeding lines and cultivars from abroad. 1974. A.P.F. Cornelissen

K.2141/07/1/4: Evaluation of the earliness of cotton (*Gossypium hirsutum*) as a factor in better insect pest and agronomic management. 1985. H.G. van Heerden

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K.2141/07/2/3: Recovery of cotton breeding lines after a period of moisture or temperature stress. 1983. H.G. van Heerden

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K.2141/19/1/1: Occurrence of different races of *Xanthomonas malvacearum* on cotton in South Africa. 1983. R.J. van Wyk

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Pests/Plae

K.2141/20/1/2: Survey and identification of parasitic nematodes in different cotton producing areas. 1982. R.J. van Wyk

K.2141/20/1/3: The effect of nematocides on different nematode species and populations on cotton. 1985. M.S. Greeff

K.2141/20/1/4: The refinement of infra-red detection techniques (for remote sensing) to determine nematode infestation in cotton for improved management. 1985. M.S. Greeff

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K.2141/30/1/2: Mulching and cultivation practices for cotton. 1983. M.C. Dippenaar

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• *Water requirements/Waterbehoeftes*

TK.2141/31/1/1: Influence of moisture deficits during different growth stages. 1977. M.C. Dippenaar

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TOBACCO/TABAK

• *Physiology/Fisiologie*

TK.2142/03/1/1: Measuring of physical characteristics of flue-cured tobacco leaf. 1987. N.J.J. Combrink

TK.2142/03/1/2: Measurement of leaf ripeness before harvest. 1987. N.J.J. Combrink

• *Nutrition/Voeding*

TK.2142/05/1/1: Nitrogen indices for and nitrogen supply of the Arcadia soil series for tobacco. 1972. C.J. Steenkamp

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• *Upgrading/Veredeling*

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- *Pathology/Patologie*

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TK.2142/19/2/5: Evaluation of *Nicotiana* species, *N. tabacum* cultivar breeding lines for possible resistance against "bushy top". 1986. R.J. van Wyk

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TK.2142/19/3/3: Chemical control of bacterial wilt in tobacco. 1986. M.C. Engelbrecht

- *Pests/Plae*

TK.2142/20/1/5: Influence of soil characteristics on the decomposition of carbofuran in tobacco cultivation. 1985. E.G. Eulitz

TK.2142/20/2/1: Control of nematodes in tobacco. 1961. R.J. van Wyk

TK.2142/20/2/4: Determination of threshold levels and infestation techniques for different soil types. 1981. S.M. Claassen

TK.2142/20/2/5: The effect of nematocides on different nematode species and populations on tobacco. 1985. M.S. Greeff

TK.2142/20/2/6: Susceptibility of rotation crops with tobacco and weed in tobacco lands for species and races of *Meloidogyne*. 1986. R.J. van Wyk

TK.2142/20/2/7: The refinement of infra-red detection techniques (for remote sensing) to determine nematode infestation in tobacco for improved farm management. 1985. M.S. Greeff

TK.2142/20/2/8: Survey of parasitic nematodes which occur in association with tobacco. 1986. M.S. Greeff

• *Chemical control/Chemiese beheer*

TK.2142/21/1/1: Chemical weed control in flue-cured tobacco plantings. 1968. J.N. de Kock

TK.2142/21/1/2: Chemical weed control in Oriental tobacco plantings. 1980. J.N. de Kock

• *Crop science/Gewaskunde*

TK.2142/30/1/1: Spacing and topping of flue-cured tobacco. 1966. F.J. Shawe

TK.2142/30/1/6: Chemical control of suckers on tobacco. 1968. J.N. de Kock

• *Technology/Tegnologie*

TK.2142/52/1/3: Curing of air-cured tobacco. 1981. J.G. Nel

• *Chemistry/Chemie*

TK.2142/53/2/4: Physical and chemical characteristics of tobacco grades. 1978. J.G. Nel

TK.2142/53/2/5: Phenolics, acids and volatile neutrals in tobacco leaf and their relationship to quality and aroma. 1985. C.R. Wall

SUNDRY AGRONOMIC CROPS/DIVERSE AKKERBOUGEWASSE

• *Crop science/Gewaskunde*

GG.2143/30/1/1: Introduction of rice breeding material. 1980. J.J. Coetzee

GG.2143/30/1/2: Evaluation of cultivars for agricultural value and adaptability. 1980. J.J. Coetzee

CHICORY/SIGOREI

• *Nutrition/Voeding*

D.2144/05/1/1: The fertilisation of chicory on an Oakleaf-Limpopo. 1981. R.S. Marr

• *Upgrading/Veredeling*

D.2144/07/1/1: The selection of chicory. 1975. R.S. Marr

• *Pathology/Patologie*

TK.2144/19/1/1: Determination of the causal organism(s) of blackrot in chicory. 1985. G.C. Prinsloo

• *Pests/Plae*

TK.2144/20/1/1: Preliminary survey of parasitic nematode genera in chicory. 1985. R.J. van Wyk

TK.2144/20/1/2: Chemical control of parasitic nematodes in chicory. 1985. R.J. van Wyk

• *Crop science/Gewaskunde*

D.2144/30/1/1: Chicory seed production. 1975. R.S. Marr

D.2144/30/1/2: The chemical control of weeds in chicory. 1975. R.S. Marr

D.2144/30/1/3: Planting and harvesting data for chicory on an Oakleaf-Limpopo. 1980. R.S. Marr

D.2144/30/1/4: The influence of preceding crops on the yield of chicory. 1980. R.S. Marr

D.2144/30/1/5: The evaluation of chicory cultivars. 1975. R.S. Marr

HORTICULTURE RESEARCH/TUINBOUNAVORSING

Tuber crops/Knolgewasse

POTATOES/AARTAPPELS

- *Physiology/Fisiologie*

GS.2411/03/1/1: The influence of calcium on the cell wall and cell structure of potato tubers. 1983. Marianne W. Venter

GS.2411/03/1/2: Physiological study regarding factors which influence tuber initiation in potatoes. 1978. F.I. du Plooy

GS.2411/03/2/1: *In vitro* storage techniques of disease-free mother material of potatoes. 1983. J.L.F. Dutrieux

GS.2411/03/2/2: Pollen culture in potatoes as a breeding technique. 1983. J.A. Brink

GS.2411/03/4/1: The evaluation of techniques to determine the physiological age of potato seed tubers. 1987. B.J. Pieterse

- *Nutrition/Voeding*

GS.2411/05/1/1: Fertiliser requirements of potatoes at Lydenburg. 1980. K.P. Prinsloo

GS.2411/05/1/4: The influence of calcium on potatoes. 1984. M.W. Venter

GS.2411/05/1/5: The influence of different levels, times and methods of nitrogen top-dressing on potato production and quality. 1981. K.P. Prinsloo

- *Upgrading/Veredeling*

GS.2411/07/1/1: Breeding of improved potato cultivars. 1983. A.F. Visser

GS.2411/07/2/1: Breeding and selection of potato cultivars for tolerance to common scab. 1963. L. Marais

GS.2411/07/2/2: Breeding and selection of potato cultivars for tolerance to bacterial wilt. 1986. A.E. Swanepoel

GS.2411/07/2/3: Breeding and selection of potato cultivars for tolerance to Fusarium diseases. 1986. J. du Preez

GS.2411/07/2/4: Breeding and selection of potato cultivars for tolerance to virus diseases. 1963. A.F. Visser

GS.2411/07/3/1: Genetic studies to broaden the genetic base of potato cultivars. 1975. A.F. Visser

GS.2411/07/4/1: Upgrading of potatoes: utilisation of normal and/or induced protocol variation. 1986. J.M. Lindeque

- *Pathology/Patologie*

GS.2411/19/1/2: Study and control of common scab on potatoes. 1978. B.W. Young

GS.2411/19/1/4: Ecology and control of black scurf on potatoes. 1979. B.W. Young

GS.2411/19/1/5: Control of silver scurf on potatoes. 1985. L. Marais

GS.2411/19/1/6: Study of silver scurf on potatoes. 1985. L. Marais

GS.2411/19/1/7: Control of anthracnose on potatoes. 1985. L. Marais

GS.2411/19/1/8: Study of anthracnose on potatoes. 1985. L. Marais

GS.2411/19/1/9: Study of *Fusarium* spp. concerned with dry rot and stemrot of potatoes. 1985. D.J. Theron

GS.2411/19/2/1: Bacterial wilt disease on potatoes caused by *Pseudomonas solanacearum*: isolation of causal bacteria. 1984. A.E. Swanepoel

GS.2411/19/2/2: Bacterial wilt disease of potatoes caused by *Pseudomonas solanacearum*: symptom development. 1984. A.E. Swanepoel

GS.2411/19/3/4: Effect of tuber stimulation on the detection of potato viruses in tomatoes. 1987. P.J. Prins

GS.2411/19/3/7: Potato virus Y in potatoes: identification and characterisation of strains. 1983. G.J. Thompson

GS.2411/19/3/8: Potato leaf roll virus: purification procedures and anti-serum preparation. 1984. P.J. Prins

GS.2411/19/3/9: Elimination of non-specific reactions in the detection of potato viruses in potatoes. 1984. P.J. Prins

- *Pests/Plae*

GS.2411/20/1/1: Biological studies of black maize beetle in potatoes. 1984. J.M.I. Donaldson

GS.2411/20/1/2: Bio-ecological studies of the potato snout beetle. 1984. J.M.I. Donaldson

GS.2411/20/2/2: The chemical control of potato tuber moth on stored potatoes. 1979. K.C. Daiber

- *Crop science/Gewaskunde*

GS.2411/30/1/1: Phase-2 evaluation of adaptibility of promising potato breeding lines in different areas 1963. J.L. Schoeman

GS.2411/30/1/2: Phase-2 evaluation of advanced breeding lines and imported cultivars in different area: 1979. J.L. Schoeman

GS.2411/30/1/3: Introduction and preliminary evaluation of foreign potato cultivars. 1973. A.F. Visser

GS.2411/30/1/4: Evaluation of commercial acceptability of promising potato breeding lines and imported cultivars. 1987. D.C.A. Hoffman

GS.2411/30/2/2: Optimal plant population for potatoes under irrigation. 1986. J.J. Nel

GS.2411/30/2/11: The investigation on the efficient utilisation of potato tubers. 1983. B.J. Pieterse

GS.2411/30/3/1: Maintenance and multiplication of genetic resources of potatoes. 1987. D.C.A. Hoffman

Vegetables/Groente

TOMATOES/TAMATIES

- *Physiology/Fisiologie*

GS.2421/03/1/1: Anther culture of tomatoes. 1987. J.A. Brink

GS.2421/03/1/2: Establishment and embryogenesis of cell cultures of tomatoes. 1987. R.P. de Villiers

- *Upgrading/Veredeling*

GS.2421/07/1/1: Breeding and selection of market tomatoes. 1975. S.E. Bosch

GS.2421/07/1/2: Breeding and selection of processing tomatoes. 1975. S.E. Bosch

• *Pathology/Patologie*

GS.2421/19/2/1: Evaluation of tomatoes for resistance to bacterial canker. 1975. B.H. Boelema

GS.2421/19/2/2: Phenotypic characteristics of *Pseudomonas syringae* pv. tomato, the bacterial speck pathogen of tomato. 1987. J.J. Serfontein

GS.2421/19/3/1: Identification and characterisation of the potyvirus group in tomatoes. 1981. G.J. Thompson

GS.2421/19/3/2: Identification and characterisation of tomato spotted wilt virus strains. 1981. G.J. Thompson

• *Pests/Plae*

GS.2421/20/1/1: A study of plant parasitic eelworm on tomatoes. 1981. K.C. Daiber

GS.2421/20/1/2: Bio-ecological studies of *Liriomyza trifolii* on tomatoes. 1985. M.C. Bolton

• *Crop science/Gewaskunde*

GS.2421/30/1/1: Evaluation of new market tomato cultivars and breeding lines. 1975. H.A. Dafel

GS.2421/30/1/2: Evaluation of processing tomato cultivars and breeding lines. 1975. H.A. Dafel

GS.2421/30/3/1: Maintenance and multiplication of genetic resources of tomatoes. 1987. D.C.A. Hoffman

GS.2421/30/3/2: Collection and description of genetic resources of tomatoes. 1987. C. Bester

• *Water requirements/Waterbehoeftes*

GS.2421/31/1/1: Measurement of tomato leaf water potential. 1985. H.A. Dafel

ONIONS/UIE

• *Upgrading/Veredeling*

GS.2422/07/1/1: Breeding and selection of Caledon globe and Australian brown onions. 1976. J.J.B. van Zijl

GS.2422/07/2/1: The breeding of F_1-hybrid onions. 1983. Elsa van der Klashorst

• *Pathology/Patologie*

GS.2422/19/1/1: Study of *Pyrenochaeta terrestris*, the pink root pathogen of onions. 1983. J.F. Ferreira

GS.2422/19/1/2: Post-harvest decay of onions by *Aspergillus niger*: epidemiology and occurrence. 1987. S.P. Naudé

• *Crop science/Gewaskunde*

GS.2422/30/1/1: Evaluation of onion cultivars and breeding lines. 1977. A.G. Comrie

GS.2422/30/2/1: Influence of seed size and certain production practices on yield and quality of onions. 1984. A.G. Comrie

GS.2422/30/2/2: Planting density of onions. 1986. A.G. Comrie

GS.2422/30/3/1: Maintenance and multiplication of genetic resources of onions. 1987. P.O. Stork

GS.2422/30/3/2: Collection and description of genetic resources of onions. 1986. Elsa van der Klashorst

COLE CROPS/KOOLGEWASSE

• *Physiology/Fisiologie*

GS.2423/03/1/1: The influence of seed treatments on the germination/physiology of cole crops: cabbage. 1984. B.H. Boelema

• *Upgrading/Veredeling*

GS.2423/07/1/2: Cole crops: breeding and selection of cauliflower. 1976. A.A. van den Berg

• *Pathology/Patologie*

GS.2423/19/1/1: A study on the phenology, epidemiology and control of black leg (*Phoma lingam*) on cole crops: cabbage in Natal. 1984. B.H. Boelema

• *Crop science/Gewaskunde*

GS.2423/30/1/1: Cole crops: phase-II evaluation of cabbage cultivars and breeding lines. 1976. P.J. Henrico

GS.2423/30/1/2: Cole crops: phase-II evaluation of cauliflower cultivars and breeding lines. 1975. C.P.J. Coetzee

GS.2423/30/1/3: Cole crops: phase-II evaluation of broccoli cultivars and breeding lines. 1981. W.P. Stapelberg

GS.2423/30/2/1: Maintenance and multiplication of genetic resources of cole crops. 1987. D.C.A. Hoffman

GS.2423/30/2/2: Collection and description of genetic resources of cole crops: cabbage. 1987. P.J. Henrico

GS.2423/30/2/3: Collection and description of genetic resources of cole crops: cauliflower. 1987. C.P.J. Coetzee

GS.2423/30/2/4: Collection and description of genetic resources of cole crops: broccoli. 1987. P.J. Henrico

• *Water requirements/Waterbehoeftes*

GS.2423/31/1/1: Determination of the water requirements of cole crops: cabbage. 1982. P.F. Nortjé

ROOT CROP VEGETABLES/WORTELAGTIGE GROENTE

• *Anatomy/Anatomie*

GS.2424/02/1/1: Root crop vegetables: anatomical studies of root development in sweet potatoes. 1986. C.P. du Plooy

• *Physiology/Fisiologie*

GS.2424/03/1/1: Root crop vegetables: physiology of storage root initiation and growth in sweet potatoes. 1986. C.P. du Plooy

• *Upgrading/Veredeling*

GS.2424/07/1/1: Root crop vegetables: breeding and selection of sweet potatoes. 1976. C.P. du Plooy

GS.2424/07/1/2: Root crop vegetables: breeding and selection of industrial sweet potatoes. 1975. C.P. du Plooy

GS.2424/07/2/1: Root crop vegetables: breeding and selection of Cape market and Chantenay Karoo carrots. 1982. A.A. van den Berg

• *Pathology/Patologie*

GS.2424/19/1/1: Root crop vegetables: virus diseases of root crop vegetables: sweet potatoes. 1981. G.J. Thompson

• *Crop science/Gewaskunde*

GS.2424/30/1/1: Root crop vegetables: phase-II evaluation of sweet potato cultivars and breeding lines. 1975. C.P. du Plooy

GS.2424/30/2/1: Root crop vegetables: phase-II evaluation of new carrot cultivars and breeding lines. 1981. A.A. van den Berg

GS.2424/30/3/1: Root crop vegetables: the influence of spacing on sweet potato production. 1982. C.P. du Plooy

GS.2424/30/4/1: Maintenance and multiplication of genetic resources of root crop vegetables: sweet potatoes. 1987. P.O. Stork

GS.2424/30/4/2: Collection and description of geneteic resources of root crop vegetables: sweet potatoes. 1987. C.P. du Plooy

GS.2424/30/4/3: Maintenance and multiplication of genetic resources of root crop vegetables: carrots. 1987. P.O. Stork

GS.2424/30/4/5: Maintenance and multiplication of genetic resources of root crop vegetables: beetroot. 1987. D.C.A. Hoffman

GS.2424/30/4/6: Collection and description of genetic resources of root crop vegetables: beetroot. 1987. A.A. van den Berg

• *Water requirements/Waterbehoeftes*

GS.2424/31/1/1: Water requirements of root crop vegetables: carrots. 1982. P.F. Nortjé

LEGUME VEGETABLES/PEULGROENTE

• *Upgrading/Veredeling*

GS.2425/07/1/1: Legume vegetables: breeding and selection of green beans. 1975. A.A. van den Berg

GS.2425/07/2/1: Legume vegetables: breeding and selection of green peas. 1975. S.E. Bosch

GS.2425/07/2/2: Legume vegetables: breeding and selection of dry peas. 1977. S.E. Bosch

• *Pathology/Patologie*

GS.2425/19/1/1: Legume vegetables: a study of halo blight of green beans. 1975. B.H. Boelema

GS.2425/19/1/2: Legume vegetables: a study of common blight of green beans. 1984. B.H. Boelema

• *Crop science/Gewaskunde*

GS.2425/30/1/1: Legume vegetables: phase-II evaluation of green bean cultivars and breeding lines. 1975. A.A. van den Berg

GS.2425/30/2/1: Legume vegetables: phase-II evaluation of green pea cultivars and breeding lines. 1975. Elsa van der Klashorst

GS.2425/30/2/2: Legume vegetables: phase-II evaluation of dry pea cultivars and breeding lines. 1977. Elsa van der Klashorst

GS.2425/30/4/1: Maintenance and multiplication of genetic resources of legume vegetables: green beans. 1987. P.O. Stork

GS.2425/30/4/2: Collection and description of genetic resources of legume vegetables: green beans. 1987. A.A. van den Berg

GS.2425/30/4/3: Maintenance and multiplication of genetic resources of legume vegetables: peas. 1987. P.O. Stork

GS.2425/30/4/4: Collection and description of genetic resources of legume vegetables: peas. 1987. C.E. Rappard

GS.2425/30/5/1: An evaluation of the efficiency and phytotoxicity of herbicides on green beans. 1981. H.A. Dafel

VINE CROPS/RANKGEWASSE

• *Upgrading/Veredeling*

GS.2426/07/1/1: Vine crop vegetables: breeding and selection of pumpkins. 1976. S.E. Bosch

GS.2426/07/1/2: Vine crop vegetables: breeding and selection of muskmelon. 1976. J.J.B. van Zijl

• *Pathology/Patologie*

GS.2426/19/1/1: Virus diseases of vine crop vegetables. 1981. Francisca W. van der Meer

• *Crop science/Gewaskunde*

GS.2426/30/1/1: Vine crop vegetables: evaluation of pumpkin cultivars and breeding lines. 1977. Elsa van der Klashorst

GS.2426/30/1/2: Vine crops: phase-II evaluation of muskmelon cultivars and breeding lines. 1976. Elsa van der Klashorst

GS.2426/30/2/1: Weed control studies in pumpkin and squashes. 1982. H.A. Dafel

GS.2426/30/3/1: Maintenance and multiplication of genetic resources of vine crops. 1987. D.C.A. Hoffman

GS.2426/30/3/2: Collection and description of genetic resources of vine crops: pumpkins. 1987. A.G. Comrie

GS.2426/30/3/3: Collection and description of genetic resources of vine crops: muskmelon. 1987. A.G. Comrie

GS.2426/30/3/4: Collection and description of genetic resources of vine crops: watermelons. 1987. C. Bester

SUNDRY VEGETABLES/DIVERSE GROENTE

• *Physiology/Fisiologie*

GS.2427/03/1/1: Sundry vegetables: the rapid propagation of asparagus (*Asparagus officinalis*) by means of tissue culture. 1986. Martha M. Slabbert

• *Crop science/Gewaskunde*

GS.2427/30/2/1: Sundry vegetables: cultivation studies with lettuce. 1983. C.P. du Plooy

GS.2427/30/3/1: Maintenance and multiplication of genetic resources of sundry vegetables: garlic. 1987. D.C.A. Hoffman

GS.2427/30/3/2: Collection and description of genetic resources of sundry vegetables: garlic. 1987. P.J. Henrico

Flowers and ornamental plants/Blomme en sierplante

PROTEAS

• *Physiology/Fisiologie*

GS.2431/03/1/1: Prevention and control of physiological leaf browning of protea. 1984. J.A. Brink

GS.2431/03/2/1: Rapid multiplication of proteas *in vitro*: *Leucospermum*. 1986. G.J. Brits

GS.2431/03/2/2: Rapid multiplication of proteas *in vitro*: *Serruria florida*. 1986. B.A. Rugge

GS.2431/03/2/3: Rapid multiplication of proteas *in vitro*: *Protea*. 1987. D.I. Ferreira

• *Upgrading/Veredeling*

GS.2431/07/1/2: Hybridisation studies with proteas: genus *Protea*. 1985. G.J. Brits

GS.2431/07/1/3: Mass selection for the upgrading of certain protea variants: genus *Protea*. 1985. G.J. Brits

GS.2431/07/1/4: Single plant selection for the development of new clonal cultivars of proteas. 1985. G.J. Brits

GS.2431/07/1/5: Upgrading of proteas as pot plants: genus *Protea*. 1987. G.J. Brits

GS.2431/07/2/1: Hybridisation studies with proteas: genus *Leucospermum*. 1985. G.J. Brits

GS.2431/07/2/2: Upgrading of proteas as pot plants: genus *Leucospermum*. 1987. G.J. Brits

GS.2431/07/3/1: Hybridisation studies with proteas: genus *Leucadendron*. 1986. G.J. Brits

GS.2431/07/3/2: Upgrading of proteas as pot plants: genus *Leucadendron*. 1987. G.J. Brits

GS.2431/07/4/1: Upgrading of proteas as pot plants: genus *Serruria*. 1987. G.J. Brits

• *Pests/Plae*

GS.2431/20/1/2: Bio-ecological studies of insects on proteas. 1986. J.H. Coetzee

GS.2431/20/2/1: Taxonomic studies of insects on proteas. 1986. J.H. Coetzee

GS.2431/20/2/2: Taxonomic studies of mites on proteas. 1986. J.H. Coetzee

GS.2431/20/3/1: Chemical control measures of pests on proteas. 1986. J.H. Coetzee

• *Crop science/Gewaskunde*

GS.2431/30/1/1: Collecting, maintaining and evaluation of protea research material. 1978. G.J. Brits

GS.2431/30/1/2: Evaluation of protea cultivars and selections. 1978. G.J. Brits

GS.2431/30/2/1: Seed reproduction of proteas. 1978. G.J. Brits

GS.2431/30/2/3: Reproduction of proteas by means of grafting and budding. 1987. D.G. Malan

GS.2431/30/3/2: Cultivation of proteas in inert media. 1987. D.G. Malan

POT PLANTS/POTPLANTE

• *Physiology/Fisiologie*

GS.2432/03/1/1: Rapid multiplication of bulb flower pot plants *in vitro*: *Lachenalia*. 1982. J.G. Janse van Rensburg

GS.2432/03/1/2: Rapid multiplication of bulb flower pot plants *in vitro*: *Lapeirousia*. 1986. E. Louw

GS.2432/03/1/3: Rapid multiplication of bulb flower pot plants *in vitro*: *Amaryllis*. 1987. M. de Bruyn

GS.2432/03/1/4: Rapid multiplication of bulb flower pot plants *in vitro*: *Crinum*. 1987. M.M. Slabbert

• *Upgrading/Veredeling*

GS.2432/07/1/1: Bulb flower pot plants: breeding and selection of *Lachenalia*. 1974. F.L. Hancke

GS.2432/07/1/2: Pot plants: breeding and selection of intergeneric hybrids of *Amaryllidacea*. 1987. A.F. Coertze

GS.2432/07/2/1: Cytogenetical study of bulb flower pot plants: *Lachenalias*. 1983. F.L. Hancke

• *Pathology/Patologie*

GS.2432/19/1/1: Identification of the virus diseases of bulb flower pot plants: *Lachenalia*. 1981. J.T. Burger

• *Crop science/Gewaskunde*

GS.2432/30/2/1: Bulb flower pot plants: manipulation of the flowering and growth period of *Lachenalias*. 1984. L. Meyer

GS.2432/30/2/2: Pot plants: *in vivo* vegetative and corm increasing techniques. 1986. L. Meyer

GS.2432/30/3/1: Maintenance and multiplication of genetic resources of bulb flower pot plants. 1987. P.J. Klesser

GS.2432/30/3/2: Collection and description of genetic resources of bulb flower pot plants: *Lachenalias*. 1987. F.L. Hancke

GS.2432/30/3/3: Collection and description of genetic resources of bulb flower pot plants: *Amaryllidaceae*. 1987. A.F. Coertze

CUT FLOWERS/SNYBLOMME

• *Physiology/Fisiologie*

GS.2433/03/1/2: Rapid multiplication of bulbous cut flowers *in vitro*: *Ornithogalum maculatum*. 1983. P.A. Landby

GS.2433/03/1/3: Rapid multiplication of bulbous cut flowers *in vitro*: *Gladiolus*. 1983. J.L.F. Dutrieux

GS.2433/03/1/4: Rapid multiplication of bulbous cut flowers *in vitro*: *Ornithogalum*. 1986. P.A. Landby

GS.2433/03/1/5: Rapid multiplication of bulbous cut flowers *in vitro*: *Nerine*. 1986. E. Louw

GS.2433/03/1/6: Rapid multiplication of bulbous cut flowers *in vitro*: *Cyrtanthus*. 1986. E. Louw

GS.2433/03/2/1: Embryo culture studies on bulbous cut flowers: *Gladiolus*. 1984. J.G.J. van Rensburg

GS.2433/03/2/3: Embryo culture studies on bulbous cut flowers: *Nerine*. 1987. J.G. Janse van Rensburg

GS.2433/03/2/4: Embryo culture studies on bulbous cut flowers: *Cyrtanthus*. 1987. B.M. Vcelar

• *Nutrition/Voeding*

GS.2433/05/1/1: Nutritional needs of bulbous cut flowers: *Ornithogalum*. 1984. A.F. Coertze

• *Upgrading/Veredeling*

GS.2433/07/1/1: Bulbous cut flowers: breeding and selection of *Ornithogalum*. 1978. F.L. Hancke

GS.2433/07/1/2: Bulbous cut flowers: breeding and selection of *Gladiolus*. 1983. S.D. Verryn

GS.2433/07/2/1: Cytogenetical studies of bulbous cut flowers: *Gladiolus*. 1986. S.D. Verryn

GS.2433/07/3/1: Sterility studies of bulbous cut flowers: *Nerine*. 1986. G. Sorour

Pathology/Patologie

GS.2433/19/1/2: Herbaceous cut flowers: synthesis and cloning of a C-DNA probe for *Chrysanthemum* stunt viroid. 1985. G.C. Botha

GS.2433/19/2/1: Shrub-like cut flowers: virus diseases of roses. 1965. P.J. Klesser

GS.2433/19/3/1: Identification of the virus diseases of certain bulbous cut flowers: *Ornithogalum*. 1981. J.T. Burger

GS.2433/19/3/2: Virus elimination by means of chemotherapy and meristem culture in bulbous cut flowers: *Ornithogalum*. 1984. B.M. Vcelar

GS.2433/19/5/1: Bulbous cut flowers: study of *Uromyces transversalis* on *Gladiolus*. 1984. J.F. Ferreira

GS.2433/19/5/2: Bulbous cut flowers: chemical control of *Uromyces transversalis* on *Gladiolus*. 1984. J.F. Ferreira

Crop science/Gewaskunde

GS.2433/30/1/2: Shrub-like cut flowers: harvesting control of roses by means of pruning practices. 1985. L. Meyer

GS.2433/30/2/2: Cut flowers: manipulation of the flowering and growth period of *Gladiolus*. 1986. L. Meyer

GS.2433/30/3/1: Maintenance and multiplication of genetic resources of bulbous cut flowers. 1987. P.J. Klesser

GS.2433/30/3/2: Collection and description of genetic resources of bulbous cut flowers: *Ornithogalum*. 1987. F.L. Hancke

GS.2433/30/3/3: Collection and description of genetic resources of bulbous cut flowers: *Gladiolus*. 1987. S.D. Verryn

Pome and stone fruits/Kern- en steenvrugte

APPLES/APPELS

Physiology/Fisiologie

VV.2441/03/2/3: A test for the occurrence of specific replant diseases of apples. 1982. H.J. van Zyl

VV.2441/03/3/2: Chemical thinning of apples. 1985. A.F. Lourens

VV.2441/03/4/2: Effect of different nitrogen sources on the utilisation of nitrogen fertilisers by apples. 1985. M. du Preez

VV.2441/03/5/2: Starch granule counts as index of keeping quality and maturity of apples. 1985. P. van der Merwe

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• *Technology/Tegnologie*

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• *Chemistry/Chemie*

WW.2471/53/1/5: Volatile components responsible for the cultivar character in Cabernet Sauvignon wine. 1981. O.P.H. Augustyn

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BRANDY/BRANDEWYN

• *Chemistry/Chemie*

WW.2472/53/1/1: The effect of specific wine components on quality of brandy. 1979. G.W.W. Wagener

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Citrus and subtropical crops/Sitrus- en subtropiese gewasse

CITRUS/SITRUS

• *Physiology/Fisiologie*

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- *Nutrition/Voeding*

SS.2481/05/1/1: Effect of different liming agents on soil acidity in citrus and avocado orchards. 1980. R.A. Abercrombie

SS.2481/05/1/2: Macro- and micro-element fertilisation of citrus in the Citrusdal area. 1971. S.F. du Plessis

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- *Upgrading/Veredeling*

SS.2481/07/1/1: Breeding and selection to obtain improved rootstocks for citrus. 1983. H.J. Breedt

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- *Virology/Virologie*

SS.2481/12/1/1: Basic studies on tristeza virus of citrus. 1976. J.N. Moll

- *Pathology/Patologie*

SS.2481/19/1/1: Control of the greening organism in citrus. 1971. S.P. van Vuuren

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- *Pests/Plae*

SS.2481/20/1/5: Control of false codling moth in citrus. 1971. P.J. Newton

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• *Water requirements/Waterbehoeftes*

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• *Physiology/Fisiologie*

SS.2482/03/1/1: Development of tissue culture techniques for the production of embryonic callus and protoplasts in pineapples. 1984. M. Fitchet

SS.2482/03/1/2: Clonal propagation of pineapples *in vitro*. 1984. M. Fitchet

• *Nutrition/Voeding*

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Pathology/Patologie

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Physiology/Fisiologie

S.2483/03/1/3: Physiological aspects of disease resistance in avocados. 1981. L.J. van Lelyveld

S.2483/03/1/4: Radioimmunoassay to determine true hormonal status of etiolated avocado stems. 1981. J.G.M. Cutting

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• *Pathology/Patologie*

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• *Technology/Tegnologie*

SS.2483/52/1/2: Controlled- and modified-atmosphere storage of avocados. 1984. D.H. Swarts

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• *Physiology/Fisiologie*

SS.2484/03/2/1: Development of tissue culture techniques for the production of embryogenic callus and protoplasts in bananas. 1985. M. Fitchet

SS.2484/03/3/1: Influence of climatic factors and water stress on physiological responses of banana. 1986. J.C. Robinson

• *Nutrition/Voeding*

SS.2484/05/1/1: Optimum leaf analysis for bananas. 1970. B.L. Smit

• *Upgrading/Veredeling*

SS.2484/07/1/1: The evaluation of promising banana selections. 1968. J.C. Robinson

• *Pathology/Patologie*

SS.2484/19/1/1: Control of Panama wilt in bananas. 1976. J.A. Herbert

• *Pests/Plae*

SS.2484/20/1/1: Nematodes attacking bananas with special reference to the burrowing nematodes. 1972. E.C. Snyman

• *Crop science/Gewaskunde*

SS.2484/30/1/1: Determination of optimal plant population and spatial arrangements for bananas. 1980. J.C. Robinson

SS.2484/30/1/2: Crop timing and forecasting with bananas in relation to time of planting, sucker selection, spacing and locality. 1980. J.C. Robinson

SS.2484/30/1/3: Commercial evaluation of tissue-cultured banana plants. 1987. J.C. Robinson

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SS.2484/31/1/2: A critical comparative evaluation of drip and micro-irrigation for bananas. 1986. J.C. Robinson

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Anatomy/Anatomie

.2485/02/1/2: Propagation biology in diverse subtropical fruits: the mango. 1984. P.D.F. Mullins

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.2485/02/1/4: Diverse subtropical fruits: phenology in relation to guava. 1987. R.J. du Preez

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.2485/03/2/2: Diverse subtropical fruits: development of a shoot tip grafting technique for granadillas. 1985. M. Nel

.2485/03/2/3: Diverse subtropical fruits: development of tissue culture techniques for the production of embryonic callus and protoplasts in mangoes. 1985. G.W. de Winnaar

.2485/03/2/4: Diverse subtropical fruits: clonal propagation of papayas *in vitro*. 1985. G.W. de Winnaar

.2485/03/2/5: Diverse subtropical fruits: development of tissue culture techniques for the production of embryonic callus, protoplasts and haploid plants in papaya. 1985. G.W. de Winnaar

Nutrition/Voeding

.2485/05/1/2: Diverse subtropical fruits: macro- and micro-element requirements of guavas. 1981. T.J. Koen

.2485/05/1/5: Diverse subtropical fruits: macro- and micro-element requirements of mangoes. 1972. B.L. Smith

Upgrading/Veredeling

2485/07/1/2: Diverse subtropical fruits: breeding and selection of relation to mangoes. 1971. J.C. Snyman

2485/07/1/3: Diverse subtropical fruits: breeding and selection of relation to guavas. 1970. C.P. Welgemoed

2485/07/1/4: Diverse subtropical fruits: breeding and selection of relation to litchis. 1981. A.J. Joubert

Pathology/Patologie

2485/19/1/1: Diseases of diverse subtropical fruits: life cycle and control of bacterial black spot of mangoes. 1972. A. Oosthuizen

2485/19/1/2: Diverse subtropical fruits: life cycle and control of mango flower malformation. 1978. J.N. Moll

2485/19/1/3: Diverse subtropical fruits: life cycle and control of blossom-end rot in guavas. 1982. N.M.G. Grech

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• *Pests/Plae*

SS.2485/20/1/1: Diverse subtropical fruits: the occurrence and control of known and new pests. 1972. E.A. de Villiers

SS.2485/20/1/2: Occurrence and control of plant parasitic nematodes in diverse subtropical fruit: mangoes. 1986. P. Willers

• *Crop science/Gewaskunde*

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SS.2485/30/2/1: Testing of diverse subtropical fruits in different localities. 1983. A.J. Joubert

• *Water requirements/Waterbehoeftes*

SS.2485/31/1/1: Water requirements of diverse subtropical fruit: guavas in the summer rainfall area. 1987. T. Anderson

• *Chemistry/Chemie*

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OTHER SUBTROPICAL CROPS/ANDER SUBTROPIESE GEWASSE

• *Nutrition/Voeding*

SS.2486/05/1/1: Other subtropical crops: macro- and micro-element requirements of tea. 1975. B.L. Smith

• *Upgrading/Veredeling*

SS.2486/07/1/1: Other subtropical crops: breeding and selection of tea. 1971. J.C. Snyman

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• *Pests/Plae*

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• *Crop science/Gewaskunde*

SS.2486/30/1/1: Planting distances for other subtropical crops with relation to coffee. 1980. K.F.M.T. de Rooster

SS.2486/30/2/1: Testing of other subtropical crops in different localities. 1975. A.J. Joubert

• *Technology/Tegnologie*

SS.2486/52/1/1: Other subtropical crops: effect of field practice and factory processes on black tea quality. 1984. L.J. van Lelyveld

2486/52/2/1: Post-harvest handling of other subtropical crops: ginger. 1986. D.H. Swarts

Chemistry/Chemie

2486/53/1/1: Other subtropical crops: browning potential of tea clones and seedlings. 1984. L.J. van Lelyveld

Nut crops/Neutgewasse

NUTS/NEUTE

Nutrition/Voeding

.2491/05/1/1: Macro- and micro-element requirements of macadamia nuts. 1968. L. Carstens

.2491/05/1/2: Macro- and micro-element requirements of pecan nuts. 1969. T.J. Koen

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.2491/19/2/1: Chemical control of anthracnose in macadamias. 1984. N.M. Grech

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.2491/20/1/1: The occurrence and control of pests on nut crops. 1972. E.A. de Villiers

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.2491/30/1/1: Testing of macadamia nut cultivars in different localities. 1969. J.H. Oosthuysen

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.2491/30/2/1: Testing of planting distances of macadamia nuts. 1971. J.H. Oosthuysen

V.2491/30/1/1: Second phase evaluation of almond cultivars in the Western Province. 1971. E.J. van Zyl

V.2491/30/1/2: Nuts: evaluation of pecan nut cultivars in the High- and Middleveld of Transvaal. 1983. T.K. Haulik

Chemistry/Chemie

V.2491/53/1/1: Nuts: effect of the changes in oil and anti-oxidants during storage on the taste of almonds. 1982. P.C. Fourie

Radioisotopes/Radioisotope

RADIOISOTOPY/RADIOïSOTOPIE

Chemistry/Chemie

V.2401/53/1/2: Radiochemical separation of 28 Mg and 28 Al in a radioisotope generator. 1983. J.M. le Roux

HORTICULTURAL CROPS/TUINBOUGEWASSE

- *Physiology/Fisiologie*

VV.24*1*1/03/2/2: Propagation of dates by means of tissue culture. 1981. S.D. Louw

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- *Nutrition/Voeding*

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- *Pathology/Patologie*

VV.24*1*1/19/1/1: The role of fungus pathogens in the early dieback of red tea. 1980. W.A. Smit

- *Crop science/Gewaskunde*

GS.24*1*1/30/1/1: Chemical weed control studies with the horticultural crop: guayle. 1981. H.A. Dafel

GS.24*1*1/30/2/1: Cultivation studies with the horticultural crop: guayle. 1983. H.A. Dafel

GS.24*1*1/30/3/1: Evaluation of different cultivars and breeding lines of the horticultural crop guayle under dryland conditions. 1981. H.A. Dafel

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VV.24*1*1/30/8/2: Horticultural crops: second and third phase evaluation of kiwi fruit cultivars and selections in the summer rainfall area. 1985. L.L. van der Merwe

VV.24*1*1/30/10/2: Horticultural crops: artificial rest breaking of kiwi fruit by climatological and chemical manipulation. 1984. G.C. Linsley-Noakes

• *Technology/Tegnologie*

VV.24*1*1/52/2/1: Horticultural crops: preparation of acceptable instant products from waste materials of red tea. 1983. E. Joubert

PLANT PROTECTION RESEARCH/PLANTBESKERMINGSNAVORSING

Entomology/Zoology/Insektekunde/Dierkunde

INSECTS/INSEKTE

• *Taxonomy/Taksonomie*

PB.2511/01/1/1: Collection of southern African insects. 1910. G.L. Prinsloo

PB.2511/01/1/5: Taxonomy of parasitic wasps, Chalcidoidea. 1970. G.L. Prinsloo

PB.2511/01/1/7: Taxonomy of Neuroptera. 1977. M.W. Mansell

PB.2511/01/1/9: Taxonomy of Hymenoptera Aculeata. 1978. C.D. Eardly

PB.2511/01/1/10: Taxonomy of Cicadellidae of southern Africa. 1973. G.L. Prinsloo

PB.2511/01/1/11: Taxonomy and distribution of weevils (Curculionidae) in southern Africa. 1985. R.G. Oberprieler

PB.2511/01/1/12: Taxonomy and distribution of Aphidoidea and Coccoidea in southern Africa. 1985. I.M. Millar

• *Pests/Plae*

PB.2511/20/1/1: Migratory locust control by aerial spray application. 1981. H.D. Brown

PB.2511/20/1/2: The outbreak dynamics of the African migratory locust. 1981. H.D. Brown

PB.2511/20/1/3: Aspects of reproduction of *Locustana migratoria* in relation to ageing and available food. 1985. H.D. Brown

PB.2511/20/2/1: Insects: predators of the harvester termite, *Hodotermes mossambicus*. 1984. Anette Nel

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PB.2511/20/2/5: The effect of termites on the natural veld in the Bloemfontein district. 1986. Anette Nel

• *Biological control/Biologiese beheer*

PB.2511/22/2/1: The use of natural enemies to control stalk borers in cereal crops. 1978. A.R. Kfir

PB.2511/22/3/1: Development of a computerised datasystem for insect pests and their natural enemies. 1983. H. van Hamburg

PB.2511/22/3/2: Handling and regulation of imported natural enemies of insect pests under quarantine conditions. 1983. H. van Hamburg

• *Integrated control/Geïntegreerde beheer*

PB.2511/23/1/2: The effect of pesticides applied under field conditions against *H. armiger* on natural enemies and red spider mite. 1978. J.D. Mohr

PB.2511/23/1/5: The use of natural enemies to control *H. armiger*. 1978. H. van Hamburg

PB.2511 23 1 6: The feeding behaviour of *Heliothis armiger* larvae and their impact on host plants. 1983. S.J. van der Walt

PB.2511 23 3 1: Evaluation of insecticides against insects which attack the spineless cactus. 1983. M.W. Pretorius

NEMATODES/AALWURMS

- *Taxonomy/Taksonomie*

PB.2512/01/1/1: Collection of nematodes in southern Africa. 1962. Esther van den Berg

PB.2512/01/1/3: Taxonomy of root-knot nematodes, *Meloidogyne* spp. 1981. K.P.N. Kleynhans

PB.2512/01/1/4: Taxonomic study of the South African Longidoridae. 1976. Esther van den Berg

MITES/MYTE

- *Taxonomy/Taksonomie*

PB.2513/01/1/1: Collection of mites of agricultural importance. 1959. Magdalena K.P. Meyer

PB.2513 01/1/2: Taxonomy and biology of predacious mites in South Africa. 1962. E.A. Ueckermann

PB.2513/01/1/3: Taxonomy of free-living Acari in South African soils. 1976. Magdalena K.P. Meyer

- *Integrated control/Geïntegreerde beheer*

PB.2513/23/1/1: Integrated control of spider mite species of agronomic crops. 1986. J.H. Botha

SPIDERS/SPINNEKOPPE

- *Taxonomy/Taksonomie*

PB.2514/01/1/1: Taxonomy of agriculturally important spiders. 1976. A.S. Dippenaar

HONEY-BEE/HEUNINGBY

- *Nutrition/Voeding*

PB.2516/05/1/2: Nectar and pollen flora of South Africa. 1969. M.F. Johannsmeier

PB.2516/05/1/3: The effect of *Drosophila* spp. on the nectar supply of eucalyptus flowers. 1983. A.P. du Toit

- *Upgrading/Veredeling*

PB.2516/07/1/1: The selection of improved breeding lines of honey-bees. 1972. R.H. Anderson

- *Pathology/Patologie*

PB.2516/19/1/1: Diseases of the adult honey-bee. 1976. B. Buys

- *Behavioural studies/Gedragstudies*

PB.2516/28/1/1: The behaviour of honey-bees in orchards during pollination. 1972. R.H. Anderson

• *Pollination/Bestuiwing*

PB.2516/29/1/1: The effect of honey-bees on sunflower pollination. 1985. A.P. du Toit

STORED GRAIN/OPGEBERGDE GRAAN

• *Pests/Plae*

PB.2518/20/1/1: The use of contact material to control insects in stored grain and grain products. 1955. J.H. Viljoen

PB.2518/20/1/2: The use of poisonous and inert gasses to control storage pests. 1959. J.H. Viljoen

PB.2518/20/1/4: The biology, distribution and identification of the genera *Trogoderma* and *Phradonoma* (Coleoptera: Dermestidae) in stored grain in South Africa. 1987. M. Jonsson

FOREST AND TIMBER/BOSBOME EN TIMMERHOUT

• *Pests/Plae*

PB.2519/20/1/1: The biology, fungal associations and control of bark beetles on pine trees. 1979. G.D. Tribe

PB.2519/20/1/2: The control of timber insects. 1955. J.K. Winstanley

PB.2519/20/1/3: The biology, pest status and control of the black pine aphid. 1977. N.J. van Rensburg

PB.2519/20/1/4: Forest and timber: the biology of the pine woolly aphid. 1982. A.J. Urban

PB.2519/20/1/5: Forest and timber: the biology and behaviour of natural enemies of pine aphids. 1984. J.F. Kirsten

PB.2519/20/1/6: Forest and timber: seasonal behaviour of natural enemies of pine aphids. 1984. J.K. Winstanley

PB.2519/20/1/7: Forest and timber: biology and control of beetle pests of *Eucalyptus* spp. 1984. G.D. Tribe

PB.2519/20/1/8: The biology of insect pests of furniture timber plantations. 1986. J.F. Morrison

PB.2519/20/1/9: The ecology and control of termites in forestry plantation. 1987. P.R. Atkinson

Plant pathology/Microbiology/Plantpatologie/Mikrobiologie

FUNGI/SWAMME

• *Taxonomy/Taksonomie*

PB.2521/01/1/1: Identification of diverse fungi. 1973. A.P. Baxter

PB.2521/01/1/4: Taxonomy of fungi: Coelomycetes of South Africa. 1982. C. Roux

PB.2521/01/1/5: The species of the fungus genus *Phytophthora* in South Africa. 1982. A.H. Thompson

PB.2521/01/1/6: Taxonomy of fungi: *Fusarium* species in South Africa. 1984. R.Y. Anelich

• *Mycology/Mikologie*

PB.2521/11/1/1: Examination of diverse feeds for toxigenic fungi. 1978. C. Roux

PB.2521/11/1/2: Role of toxigenic fungi in the occurrence of hepatogenous photosensitivity in livestock. 1971. C. Roux

PB.2521/11/2/2: Fungi associated with feeder root diseases of cereals. 1983. B. de Scott

• *Pathology/Patologie*

PB.2521/19/1/2: Seed-borne fungi of dry beans. 1982. A.P. Baxter

PB.2521/19/2/5: Factors affecting survival, sporulation and infection by the fungus *P. cinnamomi.* 1985. Sharon L. von Broembsen

PB.2521/19/2/6: Association of the fungus *P. cinnamomi* with decline and mortality of indigenous trees and shrubs. 1985. Sharon L. von Broembsen

PB.2521/19/2/7: Control of root rot of pin cushions caused by the fungus *P. cinnamomi.* 1985. Sharon L. von Broembsen

PB.2521/19/4/1: Host range, distribution and pathogenicity of the fungus *B. dothidea.* 1985. J.A. van der Merwe

PB.2521/19/4/2: Factors affecting sporulation, infection and disease development by the fungus *B. dothidea.* 1985. J.A. van der Merwe

PB.2521/19/4/3: Control of canker and dieback of cut-flower proteas caused by the fungus *B. dothidea.* 1985. J.A. van der Merwe

PB.2521/19/5/1: Host range, distribution and pathogenicity of the fungus *D. dematioidea.* 1985. Sharon L. von Broembsen

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PB.2521/19/5/3: Control of pin cushion blight caused by the fungus *D. dematioidea.* 1986. Sharon L. von Broembsen

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BACTERIA/BAKTERIEë

• *Nitrogen fixation/Stikstofbinding*

PB.2522/09/1/1: Testing of commercial bacterial inoculants for legumes. 1967. J.L. Staphorst

PB.2522/09/1/2: Selection of *Rhizobium* bacteria for inoculants. 1968. C.J. Otto

PB.2522/09/1/3: Role of lectins in specificity of *Rhizobium* bacteria. 1975. I.J. Law

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PB.2522/09/1/9: Application of nitrogen fixing bacterial inoculants to legumes through irrigation systems. 1983. J.L. Staphorst

PB.2522/09/1/11: Bacteria: possible utilisation of liquid *Rhizobium* inoculant. 1985. C.J. Otto

PB.2522/09/1/12: Bacteria: investigation of problems experienced with inoculation of pasture legumes. 1985. J.L. Staphorst

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PB.2522/09/1/14: Bacteria: production of Indole acetic acid by strains and mutants of Rhizobium - possible effects on the host plant. 1986. I.J. Law

PB.2522/09/1/15: Bacteria: role of lectins in the *Rhizobium*-legume symbiosis. 1986. I.J. Law

PB.2522/09/1/16: Bacteria: effect of foreign plasmids on the symbiotic properties of *Rhizobium meliloti.* 1986. I.J. Law

PB.2522/09/1/17: Bacteria: determination of possible genetic changes between soil isolates and laboratory cultures of *Bradyrhizobium* sp. (Lotus). 1986. H.H. Lochner

PB.2522/09/1/18: Bacteria: competition studies with root nodule bacteria and comparison of isolates of a strain of *Bradyrhizobium* sp. (Lotus) from established soil populations and laboratory cultures. 1986. H.H. Lochner

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PB.2522/19/1/1: Identification and control of bacterial pathogens of crops from various regions and institutes. 1979. C.C.P.R. Deschodt

PB.2522/19/1/2: Elimination of seed-borne bacterial pathogens from bean seed. 1974. C.C.P.R. Deschodt

PB.2522/19/1/3: Bacteria: identification and elimination of bacterial pathogens from soybean cultivars. 1985. C.C.P.R. Deschodt

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PB.2522/19/1/5: Bacteria: identification and elimination of bacterial pathogens on Guar. 1985. C.C.P.R. Deschodt

PB.2522/19/1/6: Bacteria: survey of bacterial pathogens on pasture legumes and determination of host range. 1986. C.C.P.R. Deschodt

• *Biological control/Biologiese beheer*

PB.2522/22/1/1: Bacteria: isolation, identification and biotyping of *Agrobacterium* spp. from plants and soil. 1985. F.G.H. van Zyl

PB.2522/22/1/2: Bacteria: the determination of agrocin production and sensitivity of local pathogenic and non-pathogenic *Agrobacterium* species. 1985. F.G.H. van Zyl

PB.2522/22/1/3: Bacteria: the evaluation of D286 as control strain for crown gall where K84 appears to be unsuccessful. 1985. F.G.H. van Zyl

PB.2522/22/1/4: Bacteria: the role of competition and specificity of the plant cell binding sites in the biological control of crown gall. 1985. J.L. Staphorst

PB.2522/22/1/5: Bacteria: the role of agrocins in the biological control of crown gall. 1985. J.L. Staphorst

PB.2522/22/1/6: Bacteria: the determination of factors in the Boland that is responsible for the possible suppression of crown gall on grapevine. 1985. F.G.H. van Zyl

PB.2522/22/1/7: Development of agrocin producing strains of *Agrobacterium tumefaciens*. 1984. J.L. Staphorst

VIRUSES/VIRUSSE

• *Virology/Virologie*

PB.2523/12/1/1: Investigation on the virus nature of grapevine leafroll disease. 1985. D.J. Engelbrecht

PB.2523/12/1/2: Investigations on the mealybug transmission of viruses associated with grapevine leafroll disease. 1985. D.J. Engelbrecht

PB.2523/12/1/3: Development of immunological virus detection procedures for grapevine diseases. 1985. D.J. Engelbrecht

PB.2523/12/1/4: Development of nucleic acid coupled virus detection procedures for grapevine diseases. 1985. R. Human

PB.2523/12/1/5: Detection and identification of seed-transmitted viruses in soybeans. 1985. G. Pietersen

PB.2523/12/1/6: Detection and identification of seed transmitted viruses in lupins. 1985. P.M.B. Snyman

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FOREST AND TIMBER/BOSBOME EN TIMMERHOUT

• *Pathology/Patologie*

PB.2525/19/1/6: Integrated control of forest tree diseases. 1983. J.E. Lundquist

PB.2525/19/2/1: Forest and timber: pathogenicity host range and spread of *Verticicladiella* spp. causing root diseases of pines. 1985. M.J. Wingfield

PB.2525/19/3/1: Forest and timber: host range and spread of *Diplodia pinea* on pines in South Africa. 1985. M.J. Wingfield

PB.2525/19/3/2: Forest and timber: production and liberation of conidia by *Diplodia pinea*. 1985. M.J. Wingfield

PB.2525/19/4/1: Forest and timber: the occurrence and vector associations of *Ceratocystis* species on forest trees. 1985. M.J. Wingfield

PB.2525/19/5/1: Forest and timber: host range, pathogenicity and distribution of *Mycosphaerella* needle disease of pines. 1986. M.J. Wingfield

PB.2525/19/10/1: Forest and timber: routine diagnoses of forest tree diseases in Transvaal. 1985. J.E. Lundquist

PB.2525/19/10/2: Forest and timber: routine diagnosis of forest tree diseases in the Cape Province and Natal. 1985. M.J. Wingfield

PASTURE CROPS/WEIDINGSGEWASSE

• *Pathology/Patologie*

PB.2526/19/1/9: Pasture crops: seed-borne fungal pathogens and disease transmission by seed of *Medicago* spp. 1986. S.C. Lamprecht

PB.2526/19/1/10: Pasture crops: survival and infection of *Fusarium avenaceum* on annual *Medicago* spp 1986. S.C. Lamprecht

PB.2526/19/1/11: Pasture crops: the role of *Fusarium* in a wheat-medic crop rotation system. 1986. S.C. Lamprecht

PB.2526/19/1/12: Pasture crops: yield losses by and resistance to Colletotrichum crown rot of lucerne cultivars in the Cape Province. 1985. S.H. Koch

PB.2526/19/1/13: Pasture crops: assessment of disease resistance of cultivated lucerne cultivars to above and below ground pathogens in South Africa. 1986. S.C. Lamprecht

Electron microscopy/Elektronmikroskopie

ELECTRON MICROSCOPY/ELEKTRONMIKROSKOPIE

• *Technology/Tegnologie*

PB.2541/52/1/1: Preparation and examination of biological specimens by electron microscopy. 1979. H.J. van Tonder

Weed research/Onkruidnavorsing

WEEDS/ONKRUIDE

• *Physiology/Fisiologie*

PB.2551/03/1/1: Physiology of veld invader weeds' seed germination. 1981. P.L. Campbell

PB.2551/03/2/1: Uptake and translocation of herbicides by the weed bramble (*Rubus* spp.). 1981. D.J. Erasmus

PB.2551/03/2/2: Eco-physiology of jointed cactus (*Opuntia aurantiaca*). 1984. S. Neser

• *Chemical control/Chemiese beheer*

PB.2551/21/1/1: Chemical control of the weed jointed cactus (*Opuntia aurantiaca*). 1960. H.G. Zimmermann

PB.2551/21/1/2: Chemical control of the weed nassella tussock (*Stipa trichotoma*). 1980. G.B. Harding

PB.2551/21/1/3: Chemical control of the weed mesquite (*Prosopis* spp.). 1983. G.B. Harding

PB.2551/21/1/4: Chemical control of alien veld invaders in Natal. 1983. D.J. Erasmus

PB.2551/21/1/5: Chemical control of invader weeds of localised Eastern Cape areas. 1983. B.D. Viljoen

• *Biological control/Biologiese beheer*

PB.2551/22/1/1: Biological control of the weed jointed cactus (*Opuntia aurantiaca*). 1960. H.G. Zimmermann

PB.2551/22/1/4: Biological control of the weed prickly pear (*Opuntia ficus-indica*). 1960. H.G. Zimmermann

PB.2551/22/1/5: Biological control of the weed *Lantana camara*. 1972. C.J. Cilliers

PB.2551/22/1/6: Biological control of the weeds *Hakea sericea, H. gibbosa* and *H. sauveolens*. 1972. R.L. Kluge

PB.2551/22/1/7: Biological control of the weed *Hypericum perforatum*. 1972. R.L. Kluge

PB.2551/22/1/8: Biological control and management of cactus weeds, particularly jointed cactus in South Africa. 1977. S. Neser

PB.2551/22/2/1: A study of the diseases of some indigenous and exotic weeds which are caused by local pathogens. 1979. M.J. Morris

PB.2551/22/2/2: Biological control of *Acacia* weeds by means of pathogens. 1982. M.J. Morris

• *Plant geography/Plantgeografie*

PB.2551/25/1/1: A survey of alien invasive trees and shrubs in the grassland and savanna biomes. 1986. L. Henderson

• *Ecology/Ekologie*

PB.2551/27/1/1: Ecology of the weed *Acacia longifolia*. 1983. P.J. Pieterse

PB.2551/27/1/2: Ecology of the weed nassella tussock (*Stipa trichotoma*). 1983. B.D. Viljoen

PESTICIDES/PLAAGDODERS

• *Physiology/Fisiologie*

PB.2552/03/1/1: Interaction between dimethoate and bromacil in citrus orchards. 1984. J.J.M. Meyer

PB.2552/03/1/2: Effect of pesticide breakdown in soils on phytotoxicity. 1984. E.R.I.C. Sandmann

PB.2552/03/1/3: A study of climatic factors potentiating pesticide phytotoxicity in legumes. 1984. E. van Rensburg

• *Biotesting/Biotoetsing*

PB.2552/24/1/1: The use of an algal bioassay to determine concentrations of phytosynthetic-inhibiting herbicides. 1985. J.L. Graaf

PB.2552/24/1/2: The use of plant cells and plant tissue culture to determine herbicide concentrations. 1985. J.L. Graaf

- *Technology/Tegnologie*

PB.2552/52/1/3: Study of physical characteristics of pesticide formulations. 1980. H.A. Abott

PB.2552/52/1/4: The role of adjuvants in the penetration and effectiveness of pesticides. 1985. L.P. van Dyk

PB.2552/52/1/5: The role of leaf surfaces in the effectiveness of adjuvants and pesticides. 1986. M.J. York

- *Chemistry/Chemie*

PB.2552/53/1/2: Improvement of chromatographic resolution of pesticides. 1981. P.R. de Beer

PB.2552/53/1/4: Pesticide residues in raw vegetables, fruit and animal products. 1977. L.P. van Dyk

PB.2552/53/1/5: Analysis of pesticides and their residues affecting useful plants. 1983. P. Niewoudt

PB.2552/53/1/6: Research and improvement of pesticide analysis done by the WGPA. 1984. P.R. de Beer

PB.2552/53/1/7: Development of confirmation techniques for pesticide residue analysis. 1985. Marelie Krause

ANIMAL PRODUCTION PROMOTION
DIEREPRODUKSIEBEVORDERING

ANIMAL PRODUCTION AND ANIMAL PRODUCTS RESEARCH
DIEREPRODUKSIE- EN DIEREPRODUKTENAVORSING

Animal production/Diereproduksie

BEEF CATTLE/VLEISBEESTE

Reproduction/Reproduksie

VS.3111/04/1/1: Reproduction in beef cattle: biochemical interrelationships during nutritional stress. 1984. G.W. Kay

Upgrading/Veredeling

VS.3111/07/1/1: Evaluation of beef bulls in upgrading: Bonsmara. 1980. D.J. Bosman

VS.3111/07/1/2: Beef cattle: evaluation of the Roodebos and Wesselsvlei Bonsmara breeding lines. 1982. D.J. Bosman

VS.3111/07/1/3: Upgrading studies on beef cattle - improving fertility by natural selection. 1984. M.M. Scholtz

VS.3111/07/1/4: Upgrading studies on beef cattle: the effects of selection for growth under different management systems on production efficiency. 1985. J. van der Westhuizen

VS.3111/07/1/5: Upgrading studies on beef cattle: a genetic study of the 1/29 chromosome translocation in the progency of a heterozygote Brahman bull. 1985. N.D. Nel

VS.3111/07/1/6: Upgrading studies on beef cattle: the influence of the simulation of natural selection of body mass and fertility in a large beef breed. 1985. M.M. Scholtz

VS.3111/07/1/7: Beef cattle: prediction of breeding values and quantification of genetic trends using mixed model procedures. 1985. C. Hunlun

VS.3111/07/1/8: Upgrading studies on beef cattle - the estimation of brain mass by using head measurements of cattle and rats. 1985. H.E. Theron

DAIRY CATTLE/MELKBEESTE

Physiology/Fisiologie

VS.3112/03/1/1: An investigation into *in vitro* culture techniques for hormone dependent mammary gland tissue in dairy cattle. 1983. J.P. van Zyl

VS.3112/03/1/2: Milk prolactin surge before and during parturition and production parameters in dairy cattle. 1983. J.P. van Zyl

Nutrition/Voeding

VS.3112/05/1/3: Ureum in complete diets for dairy cattle. 1982. L.J. Erasmus

VS.3112/05/1/5: Dairy cattle nutrition: establishment of a degradability database. 1985. L.J. Erasmus

VS.3112/05/1/7: Dairy cattle nutrition: strategic protein nutrition of high producing cows. 1985. B. Ferreira

VS.3112/05/1/8: Dairy cattle: the potential of a zeolite (vermiculite) as buffer in dairy cattle diets. 1986. L.J. Erasmus

VS.3112/05/1/9: Dairy cattle: the *in sacco* digestibility of amino acid of UDP in the small intestine. 1987. L.J. Erasmus

• *Upgrading/Veredeling*

VS.3112/07/1/3: Milkability and milk quality characteristics in the upgrading of dairy cattle. 1971. J.H. Hofmeyr

• *Management/Bestuur*

VS.3112/41/1/1: Biological economic data-analysing service for dairy cattle. 1981. B. Ferreira

MUTTON SHEEP/VLEISSKAPE

• *Upgrading/Veredeling*

VS.3113/07/1/1: Upgrading of mutton sheep: quantification of genetic and non-genetic components of maternal effects. 1985. J.C. Greeff

WOOLLED SHEEP/WOLSKAPE

• *Upgrading/Veredeling*

VS.3114/07/1/1: Skin and fibre characteristics in the upgrading of woolled sheep. 1972. O. Steinhagen

VS.3114/07/2/1: Upgrading of reproduction characteristics of woolled sheep by means of cross-breeding 1972. J.H. Hofmeyr

VS.3114/07/2/2: Upgrading of woolled sheep crosses: evaluation of the Gotlander and its crosses for carpet wool production. 1985. J.C. Greeff

VS.3114/07/2/3: Evaluation of selected cross-bred woolled sheep under normal farm conditions in co-operation with co-operative workers. 1985. J.C. Greeff

PELT SHEEP/PELSSKAPE

• *Reproduction/Reproduksie*

VS.3115/04/1/1: Reproduction aspects in pelt sheep: freezing of Karakul semen. 1971. J.P.C. Greyling

• *Upgrading/Veredeling*

VS.3115/07/1/1: Upgrading of pelt sheep - white Karakuls. 1980. J.H. Hofmeyr

MEAT GOATS/VLEISBOKKE

• *Reproduction/Reproduksie*

VS.3117/04/1/1: Reproduction in the Boer goat: freezing of Boer goat semen. 1974. J.P.C. Greyling

VS.3117/04/1/2: Reproduction in the meat goat: Boer goats. 1980. J.P.C. Greyling

PIGS/VARKE

• *Reproduction/Reproduksie*

VS.3119/04/1/3: Pigs: reproduction in gilts - puberty. 1982. C. Kemp

S.3119/04/1/4: Pigs: reproduction in boars - seasonal growth. 1982. C. Kemp

Nutrition/Voeding

S.3119/05/1/5: Pig nutrition: the "ideal protein" requirements of the growing pig. 1984. E.H. Kemm

S.3119/05/1/6: Pig nutrition: qualitative and quantitative aspects and implications of wheat as feed source. 1984. F.K. Siebrits

S.3119/05/1/7: Alternative feed sources for pigs - class FH sunflower seed. 1985. J. Viljoen

S.3119/05/1/9: Pig nutrition: a comparison between the mobile bag technique and the total collection of faeces to determine digestible energy. 1986. T.S. Brand

S.3119/05/1/10: Pig nutrition: the effect of thermal ammoniation on the digestibility and utilisation of bird-proof grain sorghum. 1987. T.S. Brand

S.3119/05/1/11: Pig nutrition: quantification of the variation in apparent digestible content of sorghum. 1987. T.S. Brand

Upgrading/Veredeling

S.3119/07/1/2: Upgrading of pigs: biochemical genetic typing for identification and parentage control. 1985. A. Swanepoel

CHICKENS/HOENDERS

Nutrition/Voeding

S.311*10*/05/1/1: Nutrition of laying fowls - influence of calcium on phosphorus requirements. 1977. J.J. Prinsloo

S.311*10*/05/1/2: Nutrition of laying fowls - lysine requirements. 1976. F.D.C. Labuschagne

S.311*10*/05/1/3: Nutrition of laying fowls - seasonal energy and protein levels. 1975. F.D.C. Labuschagne

S.311*10*/05/1/4: The use of grain sorghum (*Sorghum vulgare*) in chicken diets. 1982. F.D.C. Labuschagne

S.311*10*/05/1/5: The use of lupins as feed component in poultry diets. 1987. J.J. Prinsloo

Upgrading/Veredeling

S.311*10*/07/1/1: Upgrading of laying fowls - sex-linked feather colour. 1972. J.J. Joubert

S.311*10*/07/1/2: Upgrading of laying fowls - red or gold feather colour. 1971. J.J. Joubert

S.311*10*/07/1/3: Upgrading of laying fowls - combining activity. 1971. J.J. Joubert

S.311*10*/07/1/4: Upgrading of laying fowls - Australorp. 1971. J.J. Joubert

S.311*10*/07/1/5: Upgrading of laying fowls - other breeds. 1972. J.J. Joubert

S.311*10*/07/1/6: Upgrading of laying fowl breeds - New Hampshire control flock. 1976. J.J. Joubert

S.311*10*/07/1/7: Genotype environment interaction in laying fowls - upgrading of laying fowl breeds. 1976. J.J. Joubert

S.311*10*/07/2/1: Upgrading of meat type male line fowls. 1975. J.J. Joubert

S.311*10*/07/2/2: Upgrading of meat type hen line fowls. 1962. J.J. Joubert

S.311*10*/07/2/3: Male and female line genetic control flocks. 1987. J.J. Joubert

• *Nutrition/Voeding*

VS.3115/05/1/1: Nutrient requirement of other poultry - Chinese geese. 1965. M.D. Olver

VS.3115/05/1/2: Nutrient requirement of other poultry feeding systems - ducks. 1977. M.D. Olver

• *Upgrading/Veredeling*

VS.3115/07/1/1: Upgrading of other poultry - Hagedoorn system with ducks. 1965. M.D. Olver

Animal products/Diereprodukte

MEAT/VLEIS

• *Norm studies/Normstudies*

VS.3121/50/1/2: Meat production: carcass evaluation - cattle. 1975. J.F. de Bruyn

VS.3121/50/1/3: Meat production: chilling of beef carcasses. 1976. P.H. Heinze

VS.3121/50/1/8: Meat production: carcass grading system - small stock. 1981. G.G. Bruwer

VS.3121/50/1/9: Meat production: compensatory growth - cattle. 1982. J.F. de Bruyn

VS.3121/50/1/11: Meat production: porcine stress syndromes. 1984. P.H. Heinze

VS.3121/50/1/12: Meat production: the influence of vacuum packaging films on beef quality. 1984. G.L Nortjé

VS.3121/50/1/13: Meat production: quality characteristics and cooking losses of beef prepared accordin to different oven roasting methods. 1986. I.B. Zondach

VS.3121/50/1/14: Meat and meat production norm studies: a comparison of the quality characteristics goat meat with mutton. 1986. H.C. Schönfeldt

VS.3121/50/2/1: Pork production and meat norm studies: a survey of the carcass characteristics of pig carcasses in the R.S.A. 1987. G.G. Bruwer

VS.3121/50/2/2: Pork and pork production norm studies: the effects of castration and feeding unsaturated oil (sunflower seed) on the fatty acid composition of pig fat (intra- and extra-muscular). 1987. S.M. de Jong

VS.3121/50/2/3: Pork production and meat norm studies: carcass evaluation of cross-bred pigs. 1987. G.G. Bruwer

VS.3121/50/3/1: Microbiological and technological properties of fresh pork during slaughtering deboning, vacuum and gas packaging and distribution. 1987. S.J. Botha

MILK/MELK

• *Microbiology/Mikrobiologie*

VS.3123/08/1/5: Milk: preservation of milk samples for bacterial count tests. 1983. H.H.A. Lück

VS.3123/08/3/2: The shelf life of aseptical-packaged pasteurised milk. 1983. J.F. Mostert

VS.3123/08/3/4: Presence, isolation and identification of psychrotrophic bacteria in raw milk samples. 1987. G.J. Swart

VS.3123/08/4/2: Milk: assay of antibiotics. 1983. H. Gavron

Technology/Tegnologie

S.3123/52/2/1: Technological control of the metabolic activity of psychrotrophic bacteria. 1987. G.J. Swart

Chemistry/Chemie

S.3123/53/2/1: Discolourisation of UHT-milk. 1981. B.G. Venter

S.3123/53/4/1: Natural and added iodine in milk. 1981. D. Wessels

S.3123/53/4/2: Regional and seasonal tendencies and sources of contamination of pesticides in milk products. 1985. L.E. Smit

DAIRY PRODUCTS/SUIWELPRODUKTE

Microbiology/Mikrobiologie

S.3124/08/1/1: Dairy products: a genetic study of the group *N. streptococci*. 1981. H. Gavron

S.3124/08/1/3: Dairy products: bacterial content of air in dairy factories. 1983. K. Radmore

S.3124/08/2/2: Dairy products: the influence of non-starter organisms on Cheddar cheese. 1983. A.J. Kruger

S.3124/08/3/4: Enterotoxic *Escherichia coli* in dairy products. 1982. H.H.A. Lück

S.3124/08/3/5: Dairy products: the evaluation of pathogenic bacteria in milk and cheese. 1983. H. Gavron

Norm studies/Normstudies

S.3124/50/1/1: Dairy products: production and quality of butter in South Africa. 1981. J.J. du Toit

S.3124/50/1/2: Dairy products: production and quality of ice-cream in South Africa. 1983. J.J. Keller

Technology/Tegnologie

S.3124/52/1/1: Dairy products: technique studies in the concentration of whey and skim milk by ultrafiltration. 1983. T.E.H. Downes

S.3124/52/1/2: The use of products recovered by ultrafiltration in dairy products. 1972. T.E.H. Downes

S.3124/52/1/5: Dairy products: the development of a low-energy dairy spread with favourable spreadability. 1982. T.E.H. Downes

S.3124/52/1/6: Dairy products: demineralisation, processing and utilisation of cheese whey. 1982. T.E.H. Downes

S.3124/52/1/9: Dairy products: thermisation of milk for the manufacture of cheese. 1984. T.E.H. Downes

S.3124/52/1/10: Hydrolysis of lactose in cheese whey for use in dairy products or other foods. 1984. T.E.H. Downes

S.3124/52/1/11: Dairy products: the manufacture of cold water instant full-cream milk powder on a two-stage spray dryer. 1985. T.E.H. Downes

Chemistry/Chemie

S.3124/53/3/6: Levels of linoleic acid (trans) in dairy products and oils before and after processing. 1984. L.D. Nourse

VS.3124/53/3/7: Dairy products *versus* processed oils as fat-energy source: the disturbance of the metabolism of all cis-linoleic acid by the transforms as measured by growth of broiler chicks. 1984. L.D. Nourse

VS.3124/53/3/8: Dairy products *versus* processed oils as fat-energy source: the disturbance of the metabolism of all cis-linoleic acid by the transforms as measured by uncontrolled cell proliferation in tissue cultures. 1984. L.D. Nourse

VS.3124/53/3/9: The incidence of heavy metals in dairy products. 1985. D.J.W. Bester

Supporting animal research/Ondersteunende veekundige navorsing

ANIMALS/DIERE

- *Reproduction/Reproduksie*

VS.3133/04/1/2: Animal reproduction: an *in vitro* rat embryo culture bio-assay to detect exogonous teratogens (lead and copper). 1985. J.M. Burgman

- *Nutrition/Voeding*

VS.3133/05/1/6: Feed intake in the nutrition of farm animals - feed characteristics. 1981. J.P. Pienaar

VS.3133/05/1/9: Feed intake in the nutrition of farm animals - growth studies with beef steers under production conditions. 1984. J.P. Campher

VS.3133/05/1/10: Feed intake in the feeding of farm animals: quantification of digestive energy losses on different ruminant diets. 1984. N. Slabbert

VS.3133/05/1/11: Feed intake parameters in the feeding of farm animals: chromium mordant as a particle marker. 1985. J.P. Pienaar

VS.3133/05/2/6: Protein nutrition: protein turnover in muscle tissue of growing rats. 1984. F.K. Siebrits

VS.3133/05/2/7: Protein nutrition in farm animals: estimation of protein digestibility in chickens. 1985 P.H. Henning

VS.3133/05/3/4: Digestive physiology and metabolism aspects in the feeding of farm animals - glucose production. 1975. J.G. van der Walt

VS.3133/05/3/12: Digestive physiology and metabolism aspects in the feeding of farm animals - bacteria growth, Na^+ and K^+. 1980. R.I. Mackie

VS.3133/05/3/14: Digestive physiology and metabolism aspects in animal feeding - growth constants cellulolytic bacteria. 1973. R.I. Mackie

VS.3133/05/3/16: Digestive physiology and metabolism aspects in animal feeding - fibre-digesting bacteria. 1979. R.I. Mackie

VS.3133/05/3/17: Digestive physiology and metabolism aspects in the feeding of farm animals: ammonia transport and its influence on nitrogen metabolism in rumen bacteria. 1984. Johanna J Therion

VS.3133/05/3/18: Digestive physiology and metabolism aspects in the feeding of farm animals: regulation and control of proteases in pure cultures of rumen bacteria. 1984. E. Strydom

VS.3133/05/3/19: Animals: influence of lactation and nutrition on the metabolism of lipogenic precursors. 1985. J.G. van der Walt

VS.3133/05/3/20: Digestive physiology and metabolism aspects in animal feeding: partitioning of rumina acetate and propionate between lipogenesis and gluconeogenesis, respectively in sheep 1986. M.J. Linington

VS.3133/05/3/21: Digestive physiology and metabolism aspects in animal feeding - peptide transport and utilisation by rumen bacteria. 1986. K. Westlake

VS.3133/05/3/22: Digestive physiology and metabolism aspects in animal feeding: the effect of branched and straight chain C-4 and C-5 fatty amino acids on insulin, glucagon and growth hormone. 1986. S.I. van der Walt

S.3133/05/4/4: Crop residues of by-products for animal nutrition - pigs and poultry. 1982. J. Viljoen

S.3133/05/6/5: Dietary components in feeds for animal feeding: whole maize grain. 1984. J.P. Campher

S.3133/05/6/6: Dietary components in feeds for animal feeding: combinations of energy sources. 1985. P.H. Henning

S.3133/05/6/7: Dietary components in feeds for animal feeding: water-reconstituted grain sorghum in fattening diets for beef steers. 1985. N. Slabbert

S.3133/05/6/8: Dietary components in feeds for animal feeding: the influence of grain softness on the utilisation of whole maize by beef steers. 1985. N. Slabbert

S.3133/05/6/9: Dietary components in feeds for animal feeding: ammoniated grain sorghum in fattening diets for beef steers. 1987. N. Slabbert

Genetics/Genetika

'S.3133/06/1/1: Genetic defects in farm animals - hipoplasies cattle. 1979. E.H.H. Meyer

'S.3133/06/1/2: Genetic aspects of polymorphism in farm animals - milk polymorphism. 1977. E.H.H. Meyer

'S.3133/06/1/3: Genetic aspects of haemoglobins in farm animals - cattle. 1977. E.H.H. Meyer

'S.3133/06/1/4: Genetic aspects of blood typing in farm animals. 1969. S.J. du Plessis.

'S.3133/06/1/5: Genetic production models for farm animals - milk production. 1977. C.Z. Roux

'S.3133/06/1/6: Laboratory animals in genetic studies: efficiency of feed utilisation. 1978. M.M. Scholtz

'S.3133/06/1/7: Breeding of laboratory animals in genetic studies. 1977. E.H.H. Meyer

'S.3133/06/1/9: Genetic aspects of karyotyping in farm animals. 1978. N.D. Nel

'S.3133/06/1/10: Laboratory animals in genetic studies: milk production estimation techniques - rats. 1982. M.M. Scholtz

'S.3133/06/1/11: The genetic maintenance of small animal populations and the effect of in-breeding on production characteristics. 1982. J.C. Greeff

'S.3133/06/1/12: Genetic studies on farm animals: preparation of monospecific anti-sera against lymphocyte antigens for investigation into the immune system of cattle. 1985. J. Bester

'S.3133/06/1/13: Genetic studies on farm animals: development of biochemical methodology for antigen characterisation with regard to genetic aspects of the immune system. 1985. M.C. Field

Upgrading/Veredeling

'S.3133/07/1/1: Upgrading studies on indigenous animals - maintenance, evaluation and improvement of indigenous Sanga cattle. 1982. M.M. Scholtz

'S.3133/07/1/2: Upgrading studies on indigenous animals - cytogenetic studies on Nguni cattle. 1982. N.D. Nel

'S.3133/07/1/3: Upgrading of animals: the evaluation of highly fertile sheep - breeds and strains in crosses. 1982. J.C. Greeff

'S.3133/07/1/4: Upgrading studies on animals: evaluation of the influence of the importation of germ plasm on studd-cattle breeding. 1985. H.E. Theron

'S.3133/07/1/5: Animals: genetic aspects of protein and enzyme polymorphism in sheep and goats. 1985. M.C. Field

'S.3133/07/1/6: Upgrading of animals: production models and statistical methods for the breeding of farm animals. 1986. C.Z. Roux

'S.3133/07/2/1: Biotechnical research for the upgrading of farm animals: the production of monozygotic twins using embryo splitting. 1986. N.D. Nel

Biotechnology/Animal science/Biotegnologie/Veekunde

BIOTECHNOLOGY/BIOTEGNOLOGIE

- *Upgrading/Veredeling*

VS.3141/07/1/2: Biotechnological research for the upgrading of farm animals: genome mapping by restriction fragment length polymorphisms in livestock. 1987. N.D. Nel

VETERINARY RESEARCH/VEEARTSENYKUNDIGE NAVORSING

Pathological investigations/Patologiese ondersoeke

PATHOLOGICAL INVESTIGATIONS/PATOLOGIESE ONDERSOEKE

- *Pathology/Patologie*

OP.3211/19/1/1: Diagnostic pathological investigations into mortalities of animals through macro- and microscopical techniques. 1981. J.A.W. Coetzer

OP.3211/19/1/2: Diagnostic investigations into mortalities through electron microscopical techniques. 1981. L. Prozesky

OP.3211/19/2/4: Pathological investigations on and pathogenesis of *Salmonella typhimurium* infection on sheep. 1981. J.A. Neser

OP.3211/19/2/8: Pathological investigations: toxicology, clinical pathology and pathology of *Cestrum laevigatum* poisoning in sheep and cattle. 1985. J.J. van der Lugt

OP.3211/19/2/11: Toxicological, pathophysiological and pathological aspects of *Galenia africana* poisoning in sheep. 1986. J.J. van der Lugt

OP.3211/19/3/1: Pathological and ophthalmological investigations on vervet monkeys infected with Rift Valley fever virus. 1983. J.A.W. Coetzer

Food hygiene/Voedselhigiëne

ANIMAL FOODS/DIERLIKE VOEDSELS

- *Pathology/Patologie*

OP.3221/19/1/1: Animal foods: diagnosis of mastitis as a herd problem. 1981. W.H. Giesecke

OP.3221/19/1/2: Animal foods: microscopical investigation of the teat tip and canal at different stages of udder development. 1982. W.H. Giesecke

OP.3221/19/1/3: Animal foods: lacteal levels of glucose and frequencies of subclinical mastitis and other udder conditions. 1981. W.H. Giesecke

OP.3221/19/1/5: Animal foods: the effect of teat dipping on subclinical udder conditions in dairy cows milked by a machine. 1982. W.H. Giesecke

OP.3221/19/1/7: Animal foods: normal bacterial flora on bovine udders as affected by age, breed and season. 1979. Anette M. Durand

OP.3221/19/1/9: Animal foods: interlaboratory standardisation of somatic cell counts in cows' milk in the RSA. 1983. W.H. Giesecke

OP.3221/19/1/10: Animal foods: the development of the methodology for an investigation of primary prostaglandins and thromboxanes in the normal and pathological udder secretion. 1985. Z.E. Kowalski

P.3221/19/1/11: Animal foods: a methodological investigation of the lipoxygenase products of arachidonic acid in normal and pathological udder secretions and tissue homogenates. 1985. Z.E. Kowalski

P.3221/19/3/1: Animal foods: potentially pathogenic micro-elements in animal feeds. 1981. Anette M. Durand

P.3221/19/3/4: The use of bacterial adenosinetriphosphate (ATP) analysis for the determination of the bacteriological quality of animal feeds. 1985. Anette M. Durand

Technology/Tegnologie

P.3221/52/2/1: Animal foods: differentiation of the species origin of different meat types. 1983. W.H. Giesecke

Toxicological investigations/Toksikologiese ondersoeke

TOXIC SUBSTANCES/TOKSIESE STOWWE

Toxicology/Toksikologie

P.3231/18/1/1: Diagnostics of poisoning of animals by toxic substances. 1981. T.S. Kellerman

P.3231/18/2/1: The role of fungi, plants and toxic substances in the aetiology and pathogenesis of photosensitivity. 1971. T.S. Kellerman

P.3231/18/2/4: Evaluation of the efficacy of medical and industrial activated charcoals in the prophylaxis and treatment of plant poisonings and mycotoxicoses. 1984. T.S. Kellerman

P.3231/18/2/5: Salinomycin poisoning in horses. 1985. P.W. Nel

P.3231/18/2/6: Toxic substances: pathogenesis and early diagnosis of gousiekte. 1987. N. Fourie

Internal parasite investigations/Interne-parasietondersoeke

HELMINTHS/HELMINTE

Taxonomy/Taksonomie

P.3241/01/1/1: Identification of helminths and investigation of definite host ranges. 1983. E.L. Visser

P.3241/01/1/2: The taxonomy and incidence of helminths of the Cape hyrax (*Procacia capensis*). 1983. E.L. Visser

Pests/Plae

P.3241/20/1/1: Helminths: diagnosis of unknown internal parasite phenomena. 1981. J.A. van Wyk

P.3241/20/2/1: Helminths: immunology and serology of cysticercosis of cattle and pigs. 1970. E.L. Visser

P.3241/20/2/5: Helminths: epidemiology of tapeworms of ruminants. 1982. E.L. Visser

P.3241/20/2/6: Helminths: incidence and treatment of *Stilesia globipunctata* infestation in South Africa. 1983. E.L. Visser

P.3241/20/3/1: Helminths: reinfestation of cattle with bilharzia. 1969. J.A. van Wyk

P.3241/20/3/2: Helminths: influence of temperature on the development of the larval stages of *Fasciola* spp. 1979. R.M.R. Alves

P.3241/20/3/3: Helminths: development of *Fasciola* spp. of cattle and sheep in various definitive hosts. 1978. R.M.R. Alves

OP.3241/20/3/4: Helminths: pathological physiology of *Schistosoma matthee* infestation of sheep and cattle. 1969. J.A. van Wyk

OP.3241/20/3/5: Helminths: epidemiology of paramphistomiasis. 1981. J.A. van Wyk

• *Chemical control/Chemiese beheer*

OP.3241/21/1/1: Chemical control of helminths with special reference to resistance. 1982. J.A. van Wyk

• *Technology/Tegnologie*

OP.3241/52/1/1: Helminths: long-term storage of pure strains of helminths. 1973. J.A. van Wyk

OP.3241/52/1/2: Recovery of helminths and/or their ova from animals. 1976. J.A. van Wyk

OP.3241/52/1/3: Helminths: *ante-mortem* determination of worm loads in animals. 1985. J.A. van Wyk

OP.3241/52/1/4: Helminths: an investigation of various egg counting methods and the development of quicker *post-mortem* techniques for the determination of internal parasite loads. 1987. F.J. de Villiers

Reproduction investigations/Reproduksie-ondersoeke

INFERTILITY/ONVRUGBAARHEID

• *Pathology/Patologie*

OP.3251/19/1/1: Diagnostics of infertility and abortion in animals. 1973. B. Gummow

OP.3251/19/1/2: Serodiagnostics of infertility, abortion and other diseases. 1981. C.C. Williamson

OP.3251/19/2/2: Infertility: immunity to trichomoniasis in cattle. 1981. S. Herr

OP.3251/19/2/3: Infertility: ulcerative dermatosis in sheep. 1981. C.J.V. Trichard

OP.3251/19/2/5: Infertility: bacterial infections of the genitalia of sheep. 1981. B.C. Jansen

Entomological investigations/Entomologiese ondersoeke

EXTERNAL PARASITES/EKSTERNE PARASIETE

• *Entomology/Entomologie*

OP.3261/14/1/1: External parasites: identification and systematics of insects of veterinary importance. 1981. E.M. Nevill

• *Acarology/Akarologie*

OP.3261/15/1/1: External parasites: identification and systematics of ticks and mites of veterinary importance. 1981. J.B. Walker

OP.3261/15/1/2: External parasites: systematics of the genus *Rhipicephalus*. 1973. J.B. Walker

OP.3261/15/1/3: External parasites: identification and systematics of mites of veterinary importance. 1986. L.C. Jordaan

• *Pathology/Patologie*

OP.3261/19/1/1: External parasites: *Cowdria ruminantium* in *Amblyomma hebraeum*. 1977. J.D. Bezuidenhout

P.3261/19/1/2: External parasites: multiplication of arboviruses in *Culicoides* spp. 1973. E.M. Nevill

P.3261/19/1/3: External parasites: aetiology of sweating sickness. 1971. P.T. Oberem

P.3261/19/1/4: External parasites: the congenital resistance of new-born calves against heartwater. 1987. J.L. du Plessis

P.3261/19/1/8: External parasites: a biochemical study of the tissues of *Rhipicephalus evertsi, Hyalomma* spp., *Exodes rubicundus, Boophilus* spp. *Ornithodorus savignyei* with special reference to their toxins. 1984. J.D. Bezuidenhout

P.3261/19/1/9: External parasites: determination of the tick load that will ensure enzootic stability with regard to heartwater. 1984. J.L. du Plessis

P.3261/19/1/10: External parasites: the epidemiology of Karoo paralysis. 1985. J.D. Bezuidenhout

P.3261/19/1/11: External parasites: the *in vitro* cultivation of *Cowdria ruminantium*. 1985. J.D. Bezuidenhout

P.3261/19/1/12: External parasites: the role of complement, conglutinin and immune-conglutinin in the pathogenesis of heartwater. 1985. J.L. du Plessis

P.3261/19/1/13: External parasites: the use of the Welgevonden strain of *Cowdria ruminantium* for heartwater research. 1986. J.L. du Plessis

• *Pests/Plae*

P.3261/20/1/3: External parasites: biology and control of *Simulium* spp. in South Africa. 1968. L.C. Jordaan

P.3261/20/1/4: External parasites: resistance of ticks to acaricides. 1976. A.M. Spickett

P.3261/20/1/5: External parasites: tick resistance in indigenous and European cattle breeds. 1982. A.M. Spickett

P.3261/20/1/6: External parasites: the effects of host immunity of Brahman and Hereford cattle breeds on the dynamics of tick populations in a mixed sourveld environment. 1984. A.M. Spickett

P.3261/20/1/7: External parasites: hosts of *Amblyomma hebraeum* and their importance in the epidemiology of heartwater. 1985. J.D. Bezuidenhout

Virus investigations/Virusondersoeke

VIRUSES/VIRUSSE

• *Pathology/Patologie*

OP.3271/19/1/1: Diagnostics of virus diseases of animals. 1981. B.J.H. Barnard

OP.3271/19/2/3: Growth attenuation of African horse sickness viruses in tissue culture. 1968. B.J. Erasmus

OP.3271/19/2/5: Modification of bluetongue virus in tissue culture. 1970. B.J. Erasmus

OP.3271/19/2/6: Characterisation of newer orbiviruses. 1973. B.J. Erasmus

OP.3271/19/2/7: Flavivirus infection of sheep and cattle. 1981. B.J.H. Barnard

OP.3271/19/2/8: Survey of bluetongue and other viruses in *Culicoides* spp. 1979. B.J. Erasmus

OP.3271/19/2/9: Viruses: the epidemiology of bovine malignant catarrh. 1983. B.J.H. Barnard

OP.3271/19/2/10: Viruses: pathogenicity and tick transmission of Crimean Congo haemorrhagic fever in cattle and sheep. 1984. B.J. Erasmus

Highly contagious diseases/Hoogsaansteeklike siektes

HIGHLY CONTAGIOUS VIRUSES/HOOGSAANSTEEKLIKE VIRUSSE

- *Pathology/Patologie*

OP.3281/19/1/1: Diagnostics of highly contagious virus diseases of animals. 1980. G.R. Thomson

OP.3281/19/1/2: Highly contagious viruses: the development of ELISA techniques for the detection of foot-and-mouth disease (FMD) and swine vescular disease (VSD) viruses and antibodies directed against them. 1985. J.J. Esterhuyzen

OP.3281/19/2/1: Highly contagious viruses: epidemiology of African swine fever in free-living hosts. 1978. G.R. Thomson

OP.3281/19/2/3: Highly contagious viruses: the role of wild cloven-hoofed animals in the epidemiology of foot-and-mouth disease. 1981. G.R. Thomson

OP.3281/19/2/4: Highly contagious viruses: assessment of foot-and-mouth disease vaccines. 1983. C.D. Meredith

OP.3281/19/2/5: Highly contagious viruses: investigation of the excretion of SAT types of foot-and-mouth disease (FMD) virus from experimentally infected cattle. 1984. M.D. Gainaru

OP.3281/19/2/6: Gamma irradiation for the inactivation of highly contagious viruses in animal products. 1986. G.R. Thomson

Poultry and fish diseases/Pluimvee- en vissiektes

POULTRY/PLUIMVEE

- *Pathology/Patologie*

OP.3291/19/1/1: Diagnostics of disease conditions of poultry. 1981. F.W. Huchzermeyer

OP.3291/19/2/2: Altitude disease ascites of broilers. 1985. F.W. Huchzermeyer

OP.3291/19/2/3: Turkey malaria. 1985. F.W. Huchzermeyer

OP.3291/19/2/4: Studies on the pathogenicity of rough and non-typable strains of *Escherichia coli* isolated from poultry. 1987. M.A. Kloryga

FISH/VIS

- *Pathology/Patologie*

OP.3292/19/1/1: Diagnostics of disease conditions of fish. 1981. R.R. Bragg

Bacterial investigations/Bakteriese ondersoeke

BACTERIA/BAKTERIEë

- *Pathology/Patologie*

OP.32*10*1/19/1/1: Diagnostics of bacterial diseases of animals. 1981. Marijke M. Henton

OP.32*10*1/19/2/4: Bacteria: improvement of *E. coli* vaccines. 1982. P. Oberem

OP.32*10*1/19/2/7: Investigation of various culture media for optimal growth of *Camphylobacter fetus* for vaccine production. 1984. M.L. Swanepoel

OP.32*10*1/19/2/8: A study of the occurrence of plasmids and lysogenic phages and its correlation with toxin production in *Clostridium perifringens* type D. 1986. G. Groenewald

Protozoal investigations/Protosoa-ondersoeke

PROTOZOA/PROTOSOA

- *Pathology/Patologie*

OP.32*11*1/19/1/1: Diagnostics of protozoal and rickettsial diseases of animals. 1981. D.T. de Waal

OP.32*11*1/19/2/1: Protozoa: quality, safety and efficacy of Onderstepoort vaccines against bovine babesiosis. 1981. D.T. de Waal

OP.32*11*1/19/2/2: Protozoa: epidemiology of *Besnoitia besnoitii* infection in cattle. 1981. D.T. de Waal

OP.32*11*1/19/2/3: Protozoa: identity, distribution and transmission of *Theileria* spp. in South Africa. 1977. W.H. Stoltz

OP.32*11*1/19/2/6: Protozoa: *in vitro* cultivation of *Babesia* spp. with special reference to *Babesia bovis*. 1984. F.T. Potgieter

OP.32*11*1/19/2/7: Protozoa: a study of babesiosis in horses. 1984. D.T. de Waal

OP.32*11*1/19/3/1: Protozoa: the quality, safety and efficacy of Onderstepoort anaplasmosis vaccines. 1981. F.T. Potgieter

OP.32*11*1/19/3/2: Protozoa: transmission of *Anaplasma marginale* by ticks and biting insects. 1977. F.T. Potgieter

Molecular biological investigations/Molekulêre biologiese ondersoeke

MACROMOLECULES/MAKROMOLEKULE

- *Virology/Virologie*

OP.32*12*1/12/1/3: Macromolecules: serological studies of jaagsiekte retrovirus. 1982. M.S. Myer

OP.32*12*1/12/1/4: Macromolecules: cloning of jaagsiekte virus through genetic manipulation. 1982. E.S. Posnett

OP.32*12*1/12/1/6: Production of monoclonal antibodies against jaagsiekte retrovirus antigens. 1985. D.F. York

OP.32*12*1/12/1/7: Macromolecules: the distribution and role of lentiviruses in sheep in South Africa. 1986. D.W. Verwoerd

- *Protozoology/Protosoölogie*

OP.32*12*1/13/1/2: Macromolecules: isolation of DNA and the construction and partial characterisation of a genomic library of *Cowdria ruminantium*. 1987. R.E. Ambrosio

OP.32*12*1/13/1/3: Macromolecules: the development of probes for the detection of Anaplasma in bovine blood. 1987. E.M. Visser

OP.32*12*1/13/1/4: Macromolecules: the isolation and characterisation of the probes for the identification of *Babesia equi* and *Babesia caballi* in horses. 1987. E.S. Posnett

Biochemical investigations/Biochemiese ondersoeke

BIOCHEMICAL INVESTIGATIONS/BIOCHEMIESE ONDERSOEKE

- *Virology/Virologie*

OP.32*131*/12/1/7: The use of vaccinia virus expression vector for the neutralising antigen, protein P2 of bluetongue virus. 1987. Alberdina A. van Dijk

OP.32*131*/12/1/8: Biochemical investigations: an investigation of the composition and function of the virus specific tubules which are found in orbivirus infected cells. 1987. Alberdina A. van Dijk

OP.32*131*/12/1/9: Biochemical characterisation of equine encephalosis virus and the development of diagnostic genomic probes for the virus. 1987. C.J. Viljoen

OP.32*131*/12/1/10: The development and use of cloned genome segments as probes for the identification of horsesickness virus. 1987. C.W. Vroon

OP.32*131*/12/1/11: Preparation and characterisation of monoclonal antibodies to African horsesickness virus. 1987. W. van Wyngaardt

OP.32*131*/12/1/12: Biochemical investigation of the structure and function of a phosphorylated non-structural protein of bluetongue virus. 1986. S.J. Hall

OP.32*131*/12/1/13: An investigation of the composition and genetic variation of the group-specific antigen of bluetongue virus. 1987. M. Cloete

OP.32*131*/12/1/14: Identification of the nucleotide sequence coding for the neutralisation specific epitope or epitopes of bluetongue virus. 1987. N.T. van der Walt

Chemical pathology and poison chemistry/Chemiese patologie en gifstofchemie

POISONS/GIFSTOWWE

- *Toxicology/Toksikologie*

OP.32*141*/18/1/1: Poisons of and poisoning by cardiac glycosides from plants of the family Crassulaceae. 1981. L.A.P. Anderson

OP.32*141*/18/1/2: Poisons of and poisoning caused by *Cynanchum* species. 1981. G.L. Erasmus

OP.32*141*/18/1/3: Poisons of and poisoning caused by *Sarcostemma viminale*. 1984. L.A.P. Anderson

OP.32*141*/18/1/4: Poisons of and poisoning caused by *Ornithogalum thyrsoides*. 1983. J. de V. du Toit

OP.32*141*/18/1/5: An investigation of *Albizia tanganyicensis* poisoning. 1986. L.A.P. Anderson

OP.32*141*/18/1/6: An investigation of *Lasiospermum bipinnatum* poisoning. 1986. L.A.P. Anderson

OP.32*141*/18/2/1: Poisons of and poisoning caused by tremorgenic mycotoxins of *Aspergillus clavatus*. 1975. L.A.P. Anderson

AGRICULTURAL RESOURCE UTILISATION
LANDBOUHULPBRONBENUTTING

RESOURCE RESEARCH/HULPBRONNAVORSING

Primary resources/Primêre hulpbronne

SOIL/GROND

- *Soil science/Grondkunde*

GB.5111/32/1/3: Soil fertility - a basis according to which soils can be grouped. 1975. A.J. van der Merwe

GB.5111/32/1/5: Nitrogen/soil water interactions for efficient nitrogen fertilisation under dryland conditions in the summer rain cropping areas. 1983. L. Korentajer

GB.5111/32/2/1: The isolation, identification, quantitative determination and chemical reactions of growth stimulating and inhibiting organic compounds in soil and crop residues of summer and small grains. 1980. P. de L. R. Swartz

GB.5111/32/3/1: The distribution and properties of liming materials and waste products with reference to suitability for amelioration of RSA soils. 1979. H.C.H. Hahne

GB.5111/32/3/2: Silicon-phosphorus-sesquioxide relationships with a view to amelioration of acid soils with silicate. 1979. H.C.H. Hahne

GB.5111/32/3/4: Ad hoc mineralogical analyses and investigations. 1982. W.F.A. Kirsten

GB.5111/32/3/5: Morphological and mineralo-chemical studies of some South African podzols and podzolised soils. 1982. L.C. Hawker

GB.5111/32/3/7: The dynamics of neutralising agents of porous inert media and soil in a larger area. 1985. A.J. van der Merwe

GB.5111/32/4/3: The quantitative description of the soil water regimes of selected crop ecotopes. 1985. M. Hensley

GB.5111/32/5/1: The quantitative characterisation of a porous medium, e.g. soil. 1981. D.A. Russell

GB.5111/32/5/2: Quantitative characterisation of the physical genesis of soil particulate material. 1981. D.A. Russell

GB.5111/32/6/1: Detailed description of the soils of RSA (first approximation). 1983. J.L. Schoeman

GB.5111/32/6/2: A pedological investigation into soils associated with rocks of the Ventersdorp super group in the Western Transvaal. 1985. J.N.J. Viljoen

GB.5111/32/7/2: The investigation of chemical weathering on granites and felsites under different climate conditions. 1986. P.J. Claassen

GB.5111/32/8/1: The significance of ammonia losses from a range of RSA soils under laboratory conditions and to develop a model to be used to minimise such ammonia losses under field conditions. 1986. A.D.P. Botha

GB.5111/32/8/2: The significance of N losses by means of denitrification in the RSA soils. 1985. A.D.P. Botha

GB.5111/32/8/3: A study of some South African soils in which K fixation is a problem. 1985. W.F.A. Kirsten

GB.5111/32/8/4: Hydrolysis of urea in the summer rain cropping soils. 1985. L. Korentajer

GB.5111/32/8/5: Extractable soil nitrogen: evaluation of factors affecting the reliability of the equilibrium method using Auto Analyser methods for the determination of nitrogen. 1986. J.C. Johnson

GB.5111/32/8/7: The presence and distribution of anorganic nitrogen in soils. 1986. A.D.P. Botha

GB.5111/32/9/1: Neutralisation of acid subsoil. 1986. A.J. van der Merwe

GB.5111/32/9/2: Plant nutrition at high levels of neutralisation. 1987. A.J. van der Merwe

H.5111/32/3/2: The soil moisture holding capacity of soils in the Highveld Region. 1981. A.M. Hattingh

H.5111/32/3/3: Influence of crop residue on the moisture content and other physical properties of soils in the Higveld Region. 1982. A.M. Hattingh

H.5111/32/3/4: Soil: the influence of plant density and stubble load on the soil water regime and yield of maize. 1986. A.M. Hattingh

H.5111/32/4/1: The effects of different stubble mulch practices on the soil water and other physical properties of a Rensburg series. 1984. D.J. Beukes

H.5111/32/5/1: The effects of different levels of phosphorus and nitrogen on crop yield on a Rensburg soil series under stubble mulch tillage in the Highveld Region. 1984. D.J. Beukes

H.5111/32/6/1: An investigation into the macro-element status of soils in different land types in the Highveld Region. 1984. R.W. Bruce

N.5111/32/1/1: Evaluation of scooped soil density as a rapid measure of phosphorus fixation and soil texture. 1985. M.A. Johnston

N.5111/32/1/2: Soil: phosphorus reaction in the soil and the evaluation of phosphorus status with regard to various phosphorus carriers. 1987. G.R. Thibaud

T.5111/32/1/1: Soil: co-operative fertilisation and liming field trials in collaboration with the extension service in the Transvaal Region. 1970. W.F. van Wyk

T.5111/32/1/3: Soil: effect of rock phosphate and double super phosphate on optimal maize production. 1980. G.J. du Toit

T.5111/32/1/4: Soil: amelioration of soil acidity for optimum maize production. 1980. G.J. du Toit

T.5111/32/1/5: Soil: nitrogen phosphorus and potassium fertilisation on different soils for maize production. 1980. G.J. du Toit

T.5111/32/1/6: Soil: band placing *versus* plough-in of phosphorus for maize production. 1980. G.J. du Toit

T.5111/32/1/7: Soil: potassium fertilisation for maize production on soils differing in levels of potassium. 1980. G.J. du Toit

V.5111/32/1/1: Soil: the availability of potassium in a Mangano soil series to lucerne under irrigation at Sandvet. 1978. P.J. Snyman

V.5111/32/1/2: Soil: phosphorus status of and supply to different soil series in the Free State Region. 1979. P.J. Snyman

V.5111/32/1/5: Soil: a comparison of different nitrogen sources for wheat on a Hutton soil at Vaalharts. 1983. P.J. Snyman

V.5111/32/1/6: Soil: the effect of fertilisers on the sulphur status in a Hutton soil at Glen. 1984. A. van Schalkwyk

V.5111/32/1/7: Soil: the availability of phosphorus in a Mangano soil for dryland wheat at Sandvet. 1985. P.J. Snyman

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V.5111/32/1/9: Soil: the effect of fertiliser on the sulphur status of a Dundee soil at Upington. 1985. A. van Schalkwyk

W.5111/32/1/1: The macro-element status of soils of the winter rain cropping area. 1968. G.R. Thompson

W.5111/32/2/1: Soil: a study of the correlations between chemically extractable phosphorus and phosphorus absorption by different crops in the Winter Rainfall Region. 1974. G.R. Thompson

W.5111/32/2/3: The effect of gypsum on the yield of winter cereals on shallow, saline soils of the winter rain cropping area. 1980. C.P. de L. Beyers

W.5111/32/2/4: A comparison of diammonium EDTA with alternative extractants and procedures for the determination of trace elements in soils of the winter rain cropping area. 1981. T. Hammond

W.5111/32/3/1: The preparation of monoliths of representative soil types in the winter rain cropping area. 1976. G.R.C. Cooper

W.5111/32/4/1: The effect of soil type on the interaction between N and P in the Winter Rainfall Region with small grain types as indicator plants. 1985. G.R. Thompson

W.5111/32/5/1: Determination of nitrogen mineralisation potential of representative soils in the Winter Rainfall Region. 1986. G.R.C. Cooper

W.5111/32/5/2: Soil nitrogen availability as measured by various extractants and its relation to the response of small grain to N fertiliser applied to field plots. 1986. G.R.C. Cooper

WATER

- *Water requirements/Waterbehoeftes*

GB.5112/31/1/4: Flood irrigation design criteria establishment for major South African soils. 1981. D.A. Russell

GB.5112/31/2/1: Determination of water requirements of certain annual crops at Roodeplaat as a function of soil, plant and atmospheric factors. 1976. A.J. van der Merwe

- *Soil science/Grondkunde*

GB.5112/32/1/1: Reclamation of salt and sodic soils: influence of exchangeable sodium, exchange equilibria and electrolyte concentration of irrigation water. 1972. H.J.C. Smith

CLIMATE/KLIMAAT

- *Meteorology/Weerkunde*

GB.5113/33/1/1: Acquisition and processing of climatic data of the RSA. 1978. A.V. Kotze

GB.5113/33/1/2: Climate: drought investigation in order to provide an index for drought determination from meteorological data. 1979. J. Pollock

GB.5113/33/1/3: Agroclimate of subtropical crops. 1978. N.B. Human

GB.5113/33/1/8: Climate: wind surveys in citrus production areas. 1978. N.B. Human

GB.5113/33/1/9: Climate: total radiation in the Winter Rainfall Region. 1980. G.W. Matthee

GB.5113/33/1/11: Climate: the determination of the last frost dates along the Orange River with reference to the cultivation of wheat. 1985. S.L.M. Fleischer

GB.5113/33/1/12: Climate: the estimating of mean hourly temperature from daily maximum and minimum temperatures in the winter rain cropping area. 1985. J. Myburgh

GB.5113/33/2/1: Climate: correlation between weather factors and picking dates of apples. 1978. G.W. Matthee

GB.5113/33/2/3: The influence of climate on cotton. 1978. J.F. Eloff

GB.5113/33/2/5: The influence of climate on the occurrence of internal breakdown in plums in the winter rain cropping area. 1983. G.W. Matthee

GB.5113/33/2/6: The influence of climate on the occurrence of premature ripening of Bon Chretien pears in the winter rain cropping area. 1983. J. Myburgh

GB.5113/33/2/8: Determination of stress in maize as a result of soil-plant-atmosphere conductance with special reference to surface temperature and stomatal resistance. 1985. W.J. van den Berg

GB.5113/33/2/9: Climate: the testing of yield models for wheat for use in the winter rain cropping area. 1986. M. Galloway

GB.5113/33/2/10: Yield forecasting for citrus in the different production areas. 1981. N.B. Human

GB.5113/33/3/1: Microclimatic study of the Theewaterskloof Dam terrain. 1978. G.K. Viljoen

GB.5113/33/3/4: Climate: the influence of wind and windbreaks on apple production. 1981. G.K. Viljoen

GB.5113/33/4/1: In-time identification and prediction of unfavourable weather conditions for the Angora goat industry (climate). 1980. D.I. Rowswell

Energy/Energie

FUELS/BRANDSTOWWE

- *Engineering/Ingenieurskunde*

LI.5121/51/1/1: Research on and development of plant oils and alcohols for engines in agriculture. 1979. J. Fuls

Surveys and demarcation/Opnames en afbakening

SOIL SURVEYS/GRONDOPNAMES

- *Soil science/Grondkunde*

D.5131/32/1/1: Soil surveys in the Dohne-Bolo area. 1979. M.D. Hartmann

D.5131/32/1/2: Soil surveys for run-off control planning on pineapple farms of the Western Study Group in the Bathurst/Alexandria area. 1986. L.R. Hall

D.5131/32/1/5: Soil surveys for combating of erosion and the planning of farms in the Buyskloof, Nanaga and Zuney areas of Alexandria. 1987. L.R. Hall

GB.5131/32/1/1: Land type survey (terrain form, soils, climate) of the Highveld Region. 1979. J.L. Schoeman

GB.5131/32/1/2: Land type survey (terrain form, soils, climate) of the Eastern Cape Region. 1973. F. Ellis

GB.5131/32/1/3: Land type survey (terrain form, soils, climate) of the OFS Region. 1973. M. Hensley

GB.5131/32/1/4: Land type survey (terrain form, soils, climate) of Natal Region. 1973. D.P. Turner

GB.5131/32/1/5: Land type survey (terrain form, soils, climate) of Transvaal Region. 1973. J.L. Schoeman

GB.5131/32/1/6: Land type survey (terrain form, soils, climate) of the Winter Rainfall Region. 1973. F. Ellis

GB.5131/32/1/7: Land type survey (terrain form, soils, climate) of the Karoo Region. 1973. F. Ellis

GB.5131/32/2/1: Standard 1:50 000 soil survey of the Pretoria-Witwatersrand-Vereeniging complex. 1973. T.U. Yager

GB.5131/32/2/2: Standard 1:50 000 soil survey of the Cape Town-Moorreesburg-Worcester complex. 1975. F. Ellis

GB.5131/32/3/1: Soil surveys and investigations for irrigation purposes. 1973. F. Ellis

GB.5131/32/3/2: Soil surveys and investigations for purposes other than irrigation. 1974. J.L. Schoeman

N.5131/32/1/1: Farm soil surveys in Natal Region. 1980. A.D. Manson

• *Remote sensing application/Afstandwaarnemingtoepassing*

GB.5131/45/1/1: Soil surveys: investigation to evaluate Landsat-TM- and SPOT-data for mapping soils on a semi-detail scale. 1987. A.D. Argo

VELD SURVEYS/VELDOPNAMES

• *Situation analysis/Situasiebepaling*

D.5132/35/1/1: The determination of the veld condition through veld surveys in the Dohne-Bolo area. 1980. L.R. Hall

D.5132/35/1/2: *Ad hoc* veld condition surveys in the Eastern Cape Region. 1987. D.A. Dekker

D.5132/35/1/3: The development of a computerised databank for the storage and retrieval of veld condition survey data. 1987. D.A. Dekker

D.5132/35/1/4: Veld condition assessment of selected sites in the humid grass/bush communities of the Bathurst Extension Ward. 1987. D.A. Dekker

D.5132/35/1/5: Veld condition assessment in the Bedford and Adelaide magisterial districts. 1987. D.A. Dekker

D.5132/35/1/6: Veld condition surveys at Uitenhage/Fish River Valley Bushveld. 1987. H. Oosthuizen

• *Potential studies/Potensiaalstudies*

K.5132/36/1/2: Veld surveys: characterisation of key veld-soil potential classes in the arid Karoo in terms of potential and present veld condition. 1986. M. Vorster

K.5132/36/1/3: Veld surveys: characterisation of key veld-soil potential classes in the Bushmanland Karoo in terms of potential and present veld condition. 1986. M. Vorster

• *Conservation studies/Bewaringstudies*

K.5132/38/1/1: Veld surveys: determination of the erosion condition of the veld and lands in Karoo Midlands subregion of the Karoo Region. 1986. P.E.C. van Pletzen

K.5132/38/1/2: Veld surveys: determination of the erosion condition of the veld and lands in North-east subregion of the Karoo Region. 1986. P.V. de Bruyn

K.5132/38/1/3: Veld surveys: determination of the erosion condition of the veld and lands in the North-west Karoo subregion of the Karoo Region. 1986. G.J.J. Steenkamp

K.5132/38/1/4: Veld surveys: determination of the erosion condition of the veld and lands in the Great Karoo subregion of the Karoo Region. 1986. C.J. Lourens

• *Remote sensing application/Afstandwaarnemingtoepassing*

GB.5132/45/1/1: Veld survey: mapping of natural veldtypes and rangeland degradation by various satellite systems. 1987. A.D. Argo

• *Situation analysis/Situasiebepaling*

D.5133/35/1/1: Water surveys in the Dohne-Bolo area. 1980. R.F.M. Childs

FAIRLY HOMOGENEOUS AGRICULTURAL AREAS/REDELIK HOMOGENE BOERDERYGEBIEDE

• *Ecology/Ekologie*

K.5134/27/1/2: RHFA: final ordination of land types suitable for veld grazing into reasonably homogeneous farming areas in the Karoo Region. 1986. M. Vorster

K.5134/27/2/1: RHFA: classification of irrigation areas in the Extension Ward Cradock. 1980. P.S. van Heerden

K.5134/27/2/2: RHFA: classification of irrigation areas in the Extension Ward Somerset East. 1985. P.S. van Heerden

K.5134/27/3/1: Demarcation of fairly homogeneous agricultural areas in the Extension Ward Cradock. 1983. A.J. Siepker

K.5134/27/3/2: Demarcation of fairly homogeneous agricultural areas in the Extension Ward Graaff-Reinet. 1983. A.J. Siepker

K.5134/27/3/3: Demarcation of fairly homogeneous agricultural areas in the Extension Ward Jansenville. 1983. A.J. Siepker

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K.5134/27/3/5: Demarcation of fairly homogeneous agricultural areas in the Burgersdorp Extension Ward. 1983. A.J. Siepker

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K.5134/27/3/7: Demarcation of fairly homogeneous agricultural areas in the De Aar Extension Ward. 1983. A.J. Siepker

K.5134/27/3/8: Demarcation of fairly homogeneous agricultural areas in the Middelburg Extension Ward. 1983. A.J. Siepker

K.5134/27/3/9: Demarcation of fairly homogeneous agricultural areas in the Calvinia Extension Ward. 1983. A.J. Siepker

K.5134/27/3/10: Demarcation of fairly homogeneous agricultural areas in the Carnarvon Extension Ward. 1983. A.J. Siepker

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K.5134/27/3/15: Demarcation of fairly homogeneous agricultural areas in the Laingsburg Extension Ward. 1983. A.J. Siepker

K.5134/27/3/16: Demarcation of fairly homogeneous agricultural areas in the Victoria West Extension Ward. 1983. A.J. Siepker

• *Potential studies/Potensiaalstudies*

H.5134/36/1/1: Demarcation of fairly homogeneous farming areas in the Highveld Region. 1981. J.J. Scheepers

H.5134/36/1/2: The description of production possibilities of natural resources within 57 RHFAs in the Highveld Region. 1980. J.J. Scheepers

H.5134/36/1/3: The provision of production norms and techniques for agricultural commodities for various resource situations within RHFAs of the Highveld Region. 1981. J.J. Scheepers

H.5134/36/1/5: The classification of natural resources into ecotopes within 57 RHFAs in the Highveld Region. 1984. B.P. Ludick

K.5134/36/1/1: RHFA: ordination of land types suitable for crop production in the Great Brak, Great Fish and Little Fish Rivers into reasonably homogeneous farming areas in the eastern Karoo Region. 1985. M. Vorster

LAND USE/GRONDGEBRUIK

• *Situation analysis/Situasiebepaling*

N.5135/35/1/1: Present land use survey of Natal (Agriquest). 1979. J.B.M. Smith

OTHER SURVEYS/ANDER OPNAMES

• *Situation analysis/Situasiebepaling*

D.5136/35/1/1: A situation survey of present farming practices in the Stutterheim Extension Ward. 1983. P.G. King

HK.5136/35/1/1: An investigation into woolled sheep farming in the Republic of South Africa. 1982. R.E.D. Bradfield

HK.5136/35/2/1: Other surveys: an investigation into factors inhibiting the adoption of recommended veld management practices in the recognised grazing areas of the RSA. 1984. C.H. de Klerk

HK.5136/35/3/1: Other surveys: an investigation into the adoption of recommended agricultural practices in the summer rain cropping areas owing to the provision of co-ordinated information to farmers. 1985. C.H. de Klerk

N.5136/35/1/1: Changes in the extent of agriculturally eroded areas in Natal since 1950 and the relationship of such changes with land use modification and an evaluation of erosion status and sediment delivery in Natal. 1983. W.B. Russell

• *Potential studies/Potensiaalstudies*

HK.5136/36/1/1: Other surveys: agricultural development plan for Rehoboth Gebiet. 1982. C.H. de Klerk

K.5136/36/1/1: Other surveys: determination of stocking rate benchmarks in the Eastern Mixed Karoo of the Karoo Region. 1987. W. v.D. Botha

K.5136/36/1/2: Other surveys: determination of stocking rate benchmarks in the Karoo Mountain areas of the Karoo Region. 1987. W. v.D. Botha

K.5136/36/1/3: Other surveys: determination of stocking rate benchmarks in the central Karoo of the Karoo Region. 1987. W. v.D. Botha

K.5136/36/1/4: Other surveys: determination of stocking rate benchmarks in the Great Karoo of the Karoo Region. 1987. W. v.D. Botha

K.5136/36/1/5: Other surveys: determination of stocking rate benchmarks in the arid Karoo of the Karoo Region. 1987. W. v.D. Botha

K.5136/36/1/6: Other surveys: determination of stocking rate benchmarks in Bushmanland of the Karoo Region. 1987. W. v.D. Botha

K.5136/36/1/7: Other surveys: determination of stocking rate benchmarks in the western Winter Rainfall Mountain Karoo of the Karoo Region. 1987. W. v.D. Botha

K.5136/36/1/8: Other surveys: determination of stocking rate benchmarks in the Bush Scrubveld of the Karoo Region. 1987. W. v.D. Botha

• *Extension science/Voorligtingkunde*

HK.5136/40/1/1: Other surveys: an investigation into the efficiency of study groups in Transvaal. 1984. C.H. de Waal

Irrigation development/Besproeiingsontwikkeling

IRRIGATION PLANNING/BESPROEIINGSBEPLANNING

• *Crop science/Gewaskunde*

T.5141/30/1/1: Irrigation planning: the influence of row spacing and plant density on the yield of maize under trickle irrigation. 1986. W.F. van Wyk

• *Situation analysis/Situasiebepaling*

D.5141/35/1/1: The collection of data relating to existing irrigation practices in the Fish River irrigation area. 1987. R.F.M. Clacey

• *Evaluation/Evaluasie*

GB.5141/37/1/1: Evaluation of areas for irrigation development and farm layout on State Schemes. 1979. J. Myburgh

GB.5141/37/1/2: Evaluation of existing irrigation schemes. 1982. J. Myburgh

RESOURCE UTILISATION RESEARCH (CROPS)
HULPBRONBENUTTINGSNAVORSING (GEWASSE)

Field crops/Landgewasse

SUMMER GRAIN/SOMERGRAAN

• *Nutrition/Voeding*

D.5211/05/1/1: Summer grain: NPK nutrition of maize at Dohne. 1978. R.S. Marr

D.5211/05/1/2: Summer grain: NPK nutrition of maize at Sternberg. 1978. R.S. Marr

D.5211/05/1/3: Summer grain: NP nutrition of maize at Sternberg. 1980. R.S. Marr

D.5211/05/1/4: Summer grain: NP nutrition of maize at Ugie. 1980. R.S. Marr

• *Pests/Plae*

T.5211/20/1/1: Summer grain: survey of fungus-growing termites on agronomic crops. 1977. H.H. Gouse

• *Crop science/Gewaskunde*

D.5211/30/1/1: Summer grain: maize planting dates at Dairyland, Bathurst. 1979. R.S. Marr

D.5211/30/1/2: Summer grain: maize planting dates at Redlands, Bathurst. 1979. R.S. Marr

D.5211/30/1/3: Summer grain: maize planting dates at Dohne. 1978. R.S. Marr

H.5211/30/1/1: Summer grain: verification of production techniques and yield norms for grain sorghum on an Arcadia soil form in the Highveld Region. 1985. G.H. Koen

H.5211/30/1/2: Summer grain: the influence of tillage, seeding rate and fertilisation on the yield of grain sorghum on an Arcadia soil in the RHFA 6050 in the Highveld Region. 1986. G.H. Koen

H.5211/30/1/3: Summer grain: the evaluation of production techniques and yield norms for grain sorghum on a Rensburg soil form in RHFA 6018 in the Highveld Region. 1986. G.H. Koen

H.5211/30/2/1: Summer grain: verification of production techniques and yield norms for maize on a Bainsvlei soil form in the Highveld. 1985. H.S. Lombard

H.5211/30/2/2: Summer grain: production techniques and yield norms for maize in the Highveld Region. 1986. P.J. Laubscher

H.5211/30/2/3: Summer grain: soil tillage practices for maize on a Hutton and Avalon soil form in RHFA 6006 in the Highveld Region. 1986. P.J. Laubscher

V.5211/30/1/1: Summer grain: irrigation and nitrogen fertilisation studies with maize at Upington. 1985. A. van Schalkwyk

V.5211/30/1/2: Summer grain: irrigation and nitrogen fertilisation studies with maize at Vaalharts. 1985. A. van Schalkwyk

V.5211/30/2/1: Summer grain: crop residue management and seedbed preparation practices for dryland maize in a monoculture system at Sandvet. 1986. C. Engelbrecht

- *Potential studies/Potensiaalstudies*

D.5211/36/2/1: Summer grain: production and economic norms of no-till maize on a commercial scale at Dohne. 1983. J.A.G. Nel

- *Modelling/Modellering*

H.5211/42/1/1: The development of a simulation type model to predict production of the more important summer grains in the Highveld Region. 1985. P.J. van Rooyen

SMALL GRAIN/KLEINGRAAN

- *Physiology/Fisiologie*

W.5212/03/1/1: Small grain: the biology of rifgut brome (*Bromus diandrus*) in the Winter Rainfall Region. 1985. J.W. Loubser

- *Nutrition/Voeding*

W.5212/05/1/1: Small grain: the influence of time and amount of application of nitrogen fertiliser on wheat production in the Winter Rainfall Region. 1980. J.W. Loubser

- *Pathology/Patologie*

V.5212/19/1/1: Small grain: the effect of cultivars, soil/water regime and *Fusarium inoculum* levels at planting time on dryland wheat production at Glen. 1985. O. Los

V.5212/19/2/1: Small grain: investigations on the occurrence of root disease organisms of wheat in an experimental plot under irrigation at Vaalharts. 1985. J.P. Rheeder

• *Pests/Plae*

V.5212/20/1/1: Small grain: investigation on the occurrence of the brown wheat mite under dryland conditions at Glen. 1984. J. de Jager

V.5212/20/1/2: Small grain: investigations on the effect of the brown wheat mite on grain yield, as well as possible control measures under dryland conditions at Glen. 1984. J. de Jager

W.5212/20/1/1: Small grain: a study of the identity, occurrence, biology and ecology of aphids on small grain in the Winter Rainfall Region. 1975. S.S. Walters

W.5212/20/1/2: The pest status of aphids associated with small grain in the Winter Rainfall Region. 1978. S.S. Walters

W.5212/20/1/3: Small grain: bio-ecological study of *Sitobion avenae* on small grain in the winter rain cropping area of the Winter Rainfall Region. 1984. J.M. Laubscher

W.5212/20/2/1: Small grain: biology and control of the dune mole-rat (*Bathyergus suillus*). 1986. J. de V. Burger

W.5212/20/3/1: Small grain: factors influencing the distribution and abundance of the dune snail, *Theba pisana* and related pest snails in the Winter Rainfall Region. 1986. J. de V. Burger

• *Chemical control/Chemiese beheer*

W.5212/21/1/1: Chemical weed control of different broad leaf and grass weeds in small grain production in the Winter Rainfall Region. 1974. J.W. Loubser

W.5212/21/1/2: The influence of chemical pre-emergence control of weeds on the yield of cereals in the Winter Rainfall Region. 1977. J.W. Loubser

• *Crop science/Gewaskunde*

H.5212/30/1/1: Small grain: verification of production techniques and yield norms for wheat on an Avalon soil form in the Highveld Region. 1985. G.G.J. Oosthuizen

V.5212/30/1/1: Small grain: irrigation and nitrogen fertilisation studies with wheat in the Lower Orange River area at Upington. 1983. A. van Schalkwyk

V.5212/30/1/2: Small grain: irrigation and nitrogen fertilisation studies with wheat in the Vaalharts irrigation area. 1983. A. van Schalkwyk

V.5212/30/1/3: Small grain: irrigation and nitrogen fertilisation studies with wheat grown in rotation with maize at Vaalharts. 1984. A. van Schalkwyk

V.5212/30/2/1: Small grain: evaluation of crop residue management, soil tillage and wheat control practices within specific systems of dryland wheat production at Glen. 1982. A.J. van der Westhuizen

V.5212/30/2/2: Small grain: evaluation of minimum tillage and stubble mulch practices in dryland wheat production at Glen. 1984. A.J. van der Westhuizen

V.5212/30/2/3: Small grain: the effect of different soil management practices during long fallow preceeding dryland wheat on physical soil condition and occurrence of wind erosion at Bainsvlei. 1984. A.J. van der Westhuizen

V.5212/30/2/4: Small grain: evaluation of minimum tillage and stubble mulch practices in dryland wheat production at Sandvet. 1984. A.J. van der Westhuizen

W.5212/30/1/1: Small grain: the evaluation of released cultivars in respect of yield and quality in the Winter Rainfall Region. 1974. G.A. Agenbag

W.5212/30/2/1: Small grain: the influence of sowing date, seeding rate, variety, nitrogen application and disease control on yield and quality of barley in the Winter Rainfall Region. 1974. F.P. Goosen

W.5212/30/2/2: Small grain: the influence of disease control, nitrogen fertilisation and seeding rate on the yield and nitrogen content of malting barley in the Winter Rainfall Region. 1985. F.P. Goosen

W.5212/30/2/3: Small grain: the influence of disease control, nitrogen fertilisation and seeding rate on the yield and nitrogen content of malting barley under supplementary irrigation in the Winter Rainfall Region. 1985. F.P. Goosen

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W.5212/30/3/2: Small grain: influence of genotype, environment and nitrogen fertiliser on quality components of wheat in the Winter Rainfall Region. 1985. W.R.M. de Witt

W.5212/30/4/1: Small grain: the effect of cultivation methods in different cropping systems on grain yield and soil improvement in the Swartland production area of the Winter Rainfall Region. 1975. G.A. Agenbag

W.5212/30/4/2: Small grain: the effect of cultivation methods in different cropping systems on grain yield and soil improvement in the Ruens production area of the Winter Rainfall Region. 1976. G.A. Agenbag

W.5212/30/4/3: Small grain: the effect of cultivation methods in different cropping systems on grain yield and soil improvement in the George-Knysna production area of the Winter Rainfall Region. 1979. G.A. Agenbag

W.5212/30/5/1: A study of the adaptability of small grain species and cultivars in the Winter Rainfall Region for fodder grain purposes. 1985. F.H. Eksteen

W.5212/30/6/1: The influence of chlormequat on growth and yield of cereals in the Winter Rainfall Region. 1987. L.W. Loubser

OIL AND PROTEIN SEEDS/OLIE- EN PROTEïENSADE

• *Physiology/Fisiologie*

W.5213/03/1/1: Oil and protein seeds: effect of time of application of a seaweed growth regulator on growth, development and seed yield of lupins. 1986. H.J.C. Agenbag

• *Nutrition/Voeding*

H.5213/05/1/1: Oil and protein seeds: the growth and yield of soybeans on a Bainsvlei soil form in the Highveld Region as influenced by different phosphate levels. 1983. P.J. Laubscher

• *Upgrading/Veredeling*

W.5213/07/1/1: Oil and protein seeds: upgrading of lupins for the winter rain cropping areas by means of genetic studies and breeding. 1981. H.J.C. Agenbag

• *Chemical control/Chemiese beheer*

W.5213/21/1/1: Oil and protein seeds: chemical control of powdery mildew (*Erysiphe polygoni*) on different cultivars of *Lupinus angustifolius*. 1986. H.J.C. Agenbag

W.5213/21/2/1: Oil and protein seeds: chemical weed control in *L. albus* and *L. angustifolius* in the winter rain cropping area. 1986. J.W. Loubser

• *Crop science/Gewaskunde*

H.5213/30/1/1: Oil and protein seeds: evaluation of plant population and row width for sunflowers on a Rensburg soil form in RHFA 6018 in the Highveld Region. 1986. H.S. Lombard

W.5213/30/1/1: Oil and protein seeds: a study of the adaptability and methods of cultivation of jojoba (*Simmondsia chenensis*) in the Winter Rainfall Region. 1980. D.J. le Roux

W.5213/30/1/2: Oil and protein seeds: the evaluation of cultivars of different species of lupins with respect to adaptability disease resistance and yield in the Winter Rainfall Region. 1958. H.J.C. Agenbag

W.5213/30/2/1: Oil and protein seeds: lupin cultivar evaluation in the Winter Rainfall Region. 1986. H.J.C. Agenbag

W.5213/30/3/1: Oil and protein seeds: determination of optimum time of planting and plant density of different lupin varieties in the Winter Rainfall Region. 1986. H.J.C. Agenbag

W.5213/30/3/2: Oil and protein seeds: effect of row spacing on plant development and seed yield of *Lupinus albus*. 1986. H.J.C. Agenbag

W.5213/30/3/3: Oil and protein seeds: scientific crop studies on lupins in the Winter Rainfall Region. 1986. H.J.C. Agenbag

OTHER FIELD CROPS/ANDER LANDGEWASSE

- *Nutrition/Voeding*

W.5214/05/1/1: Other field crops: the influence of nitrogen topdressings on peppermint (*Mentha piperita*) grown in the Winter Rainfall Region. 1985. H.H.M. van Gelder

- *Upgrading/Veredeling*

D.5214/07/1/1: Other field crops: upgrading of existing chicory cultivars in the Eastern Cape. 1974. R.S. Marr

- *Crop science/Gewaskunde*

D.5214/30/1/1: Other field crops: the contribution of chicory cultivars in the Eastern Cape. 197[illegible] R.S. Marr

D.5214/30/1/4: Other field crops: crop rotation for chicory in the Eastern Cape. 1980. R.S. Ma[illegible]

W.5214/30/1/1: The evaluation of techniques and methods for application of nutrients and irrigation to other crops in a research glasshouse. 1984. H.H.M. van Gelder

W.5214/30/2/1: Other field crops: the evaluation of peppermint (*Mentha piperita*) for adaptatio[illegible] in the Winter Rainfall Region. 1985. H.H.M. van Gelder

W.5214/30/2/2: The influence of growth stage at harvest on the yield and quality of peppermint oil. 1986. H.H.M. van Gelder

Garden crops/Tuingewasse

TUBER CROPS/KNOLGEWASSE

- *Pests/Plae*

W.5221/20/1/1: Tuber crops: the migratory habits of aphid vectors of potato viruses in the seed potato producing areas of the winter rain cropping area. 1976. S.S. Walters

VEGETABLES/GROENTE

- *Pathology/Patologie*

N.5222/19/2/1: Vegetables: effect of different fungicides on the development of late blight, early blight and *Septoria* leaf spot in the vegetable cultivars "Floradade" and "Roma". 1984. W.G. Nevill

N.5222/19/2/2: Vegetables: effect of different fungicides on the development of late blight, early blight and *Septoria* leaf spot on the tomato cultivar Moneymaker. 1985. W.G. Nevill

N.5222/19/2/3: Vegetables effect of different fungicide spray application schedules on the progress of early blight on tomato cultivars. 1985. W.G. Nevill

N.5222/19/2/4: Effect of nitrogen, phosphorus and potassium fertilisation on the development of early blight on tomato cultivars. 1985. W.G. Nevill

• *Crop science/Gewaskunde*

N.5222/30/1/1: Vegetables: cultivar evaluation of vegetables in the mist belt of the high rainfall areas of Natal and the effects of selected fungicides on foliar disease development. 1985. G.W. Staveley

OTHER GARDEN CROPS/ANDER TUINGEWASSE

• *Crop science/Gewaskunde*

W.5223/30/1/1: Other garden crops: status determination with regard to the commercial utilisation of the Proteaceae in the Winter Rainfall Region. 1985. C.J. Eksteen

Fruit crops/Vrugtegewasse

GRAPES/DRUIWE

• *Pests/Plae*

W.5232/20/1/1: Distribution and movement patterns of the Cape sparrow *Passer melanurus* (Müller) - a problem bird of grapes in the irrigation areas of the Winter Rainfall Region. 1985. M.J.F. Jarvis

W.5232/20/1/2: Food composition and feeding habits of the Cape sparrow *Passer melanurus* (Müller) - a problem bird of grapes in the irrigation areas of the Winter Rainfall Region. 1985. M.J.F. Jarvis

W.5232/20/1/3: Control techniques for the Cape sparrow *Passer melanurus* (Müller) in grapes in the irrigation areas of the Winter Rainfall Region. 1985. M.J.F. Jarvis

RESOURCE UTILISATION RESEARCH (ANIMALS) HULPBRONBENUTTINGSNAVORSING (DIERE)

Ruminants/Herkouers

LARGE STOCK/GROOTVEE

• *Physiology/Fisiologie*

D.5311/03/1/1: Large stock: hormonal status and calving percentage of beef cows and heifers in the sourveld. 1979. J.A. Erasmus

D.5311/03/1/2: Large stock: protein energy status and calving percentage of beef cows and heifers in the sourveld. 1980. J.A. Erasmus

D.5311/03/2/1: Large stock: the influence of kikuyu on the sexual maturity of Friesian heifers. 1984. J.A. Erasmus

D.5311/03/2/2: Large stock: influence of kikuyu on the protein and energy status as well as certain endocrinological secretions in cows. 1984. J.A. Erasmus

D.5311/03/2/3: Large stock: influence of kikuyu pastures on the protein and energy status of dairy heifers. 1984. W.P. Henning

T.5311/03/1/2: Large stock: influence of different over-wintering feeding regimes on production and growth of beef cattle. 1971. P. Langenegger

T.5311/03/1/3: Large stock: milk and meat production from a dual purpose breed on natural veld and dryland *Cenchrus* pastures. 1984. E.E. Lademann

• *Reproduction/Reproduksie*

N.5311/04/1/1: Effect of preparation feeding levels and target mass at mating on reproduction in female beef cattle. 1979. A.P. van Schalkwyk

N.5311/04/1/2: Oestrus and ovulation in mature female beef cattle as affected by changes in live mass. 1978. B.P. Louw

N.5311/04/1/5: Large stock: the relationship between libido and mating activity in Zebu bulls. 1987. J.S. Crichton

V.5311/04/1/1: Large stock: an investigation on practical methods for shortening the inter-calving period of Afrikaner cattle at Armoedsvlakte. 1979. J.A. Vermeulen

V.5311/04/1/2: Large stock: control of LH release during synchronised oestrus of beef cows at Armoedsvlakte. 1979. J.A. Vermeulen

• *Nutrition/Voeding*

D.5311/05/1/1: Large stock: the relationship in the seasonal variation in beta carotene of sourveld and beta caroteen of blood plasm in beef cows. 1983. P.J.L. Zeeman

D.5311/05/1/2: Large stock: the influence of beta carotene supplementation on the reproduction of beef cows. 1983. J.A. Erasmus

D.5311/05/1/3: Large stock: the influence of reproduction on diet selection of beef cattle grazing high rainfall sourveld. 1983. P.J.L. Zeeman

D.5311/05/1/4: Large stock: the influence of reproduction on diet selection of beef cattle grazing sweet grassveld. 1983. P.J.L. Zeeman

D.5311/05/2/1: Large stock: the evaluation of kikuyu pastures for milk production. 1984. W.P. Henning

D.5311/05/2/2: Large stock: the evaluation of kikuyu pastures for dairy heifers. 1984. P.J. Olivier

D.5311/05/2/3: Large stock: the influence of alkali treatment of whole maize on milk production. 1984. W.P. Henning

H.5311/05/1/2: Large stock: optimal summer utilisation of fertilised and unfertilised veld with year-old steers. 1982. A.R. Schutte

H.5311/05/1/3: Large stock: the optimal level of phosphorus supplementation for beef cows on summer veld in the Highveld Region. 1985. A.R. Schutte

H.5311/05/2/2: Large stock: the utilisation of ensiled mixtures of cattle manure and maize crop residues by large stock. 1983. L.D. Snyman

H.5311/05/2/3: Large stock: the fermentation characteristics and nutritional value of maize-, grain sorghum-, forage sorghum- and sunflower silages ensiled with or without lactic acid producing bacteria. 1986. C.H.M. de Brouwer

H.5311/05/2/4: Large stock: the fattening of weaner beef steers on maize-, grain sorghum- and forage sorghum-silage. 1986. A.R. Schutte

H.5311/05/3/3: Large stock: the inclusion of different buffer levels in starter concentrates for dairy calves. 1985. C.W. Cruywagen

H.5311/05/3/4: Large stock: the effect of curd forming ability of colostrum on the absorption of antibodies in dairy calves. 1985. C.W. Cruywagen

H.5311/05/3/5: Large stock: different concentrate to roughage ratios in complete rations for Friesland bull calves. 1985. C.W. Cruywagen

H.5311/05/3/6: Large stock: the effect of curd forming ability of a milk replacer on its digestibility and body mass gain of Fresian bull calves. 1986. C.W. Cruywagen

H.5311/05/3/7: Large stock: the effect of level of milk feeding and weaning age on pre- and post-weaning growth of Friesian bull calves. 1986. Joretha G. Horn

H.5311/05/4/3: Large stock: milk production with maize silage or pasture as sources of roughage for dairy cows. 1984. Joretha G. Horn

H.5311/05/5/1: Large stock: the utilisation of cultivated summer pasture by Friesland heifers from weaning up to six months of age. 1985. Joretha G. Horn

H.5311/05/5/2: Large stock: the utilisation of cultivated winter pasture by Friesland heifers from weaning up to six months of age. 1985. Joretha G. Horn

H.5311/05/5/3: Large stock: the dry matter intake and mass gain of Friesland heifers (spring calves) from six to 24 months of age on cultivated pasture. 1985. Joretha G. Horn

H.5311/05/5/4: Large stock: dry matter intake and mass gain of Friesland heifers (autumn calves) from six to 24 months of age on cultivated pasture. 1986. Joretha G. Horn

H.5311/05/6/1: Large stock: *in vitro* evaluation of the grain of different sorghum varieties for possible inclusion in concentrates of dairy cows. 1985. C.W. Cruywagen

H.5311/05/8/2: Large stock: chemical composition and *in vitro* dry matter digestibility of different forms of utilisation of grain sorghum residues. 1986. L.D. Snyman

N.5311/05/2/1: Large stock: evaluation of *E. curvula* silage ensilaged at the May cutting stage for overwintering replacement of beef cattle heifers. 1981. A. van Niekerk

N.5311/05/2/3: Large stock: utilisation of maize residues by pregnant beef cows in the high rainfall sourveld area at Dundee. 1985. J.S. Chrichton

N.5311/05/3/2: Large stock: chemical composition and nutritive value of Tall Fescue pasture for lactating dairy cattle in the high rainfall area at Cedara. 1980. T.J. Dugmore

N.5311/05/3/3: Large stock: the causes of nutritional disorders of dairy cattle grazing kikuyu pastures damaged by army worms in the high rainfall sourveld area at Cedara. 1985. S.F. Lesch

N.5311/05/3/4: Large stock: the effect of nitrogen status and stage of regrowth on the chemical composition nutritive value, dry matter intake and milk production potential of kikuyu herbage. 1987. T.J. Dugmore

N.5311/05/3/5: Large stock: nutrition: a survey of the iodine status of dairy cattle in Natal as reflected in the iodine content of milk. 1986. J.B.J. van Ryssen

T.5311/05/1/1: Large stock: supplementary feeding of beef cattle cows with calves in the sweet bushveld. 1965. C.J.F. Lüdemann

T.5311/05/1/2: Large stock: supplementary feeding on sweet bushveld and finishing in pens of growing beef cattle. 1965. C.J.F. Lüdemann

T.5311/05/1/3: Large stock: supplementary feeding of growing cattle in the high rainfall sourveld. 1971. P. Langenegger

T.5311/05/2/1: Large stock: the value of bush species for the survival of beef cattle in the bushveld. 1983. E.E. Lademann

V.5311/05/1/1: Large stock: the evaluation of the nutritive value of veld with the aim at meat production at Vaalharts. 1974. E.A.N. Engels

V.5311/05/1/2: Large stock: a study on the influence of phosphorus status on the production and reproduction of beef cattle on veld of Armoedsvlakte. 1978. E.A.N. Engels

V.5311/05/1/3: Large stock: different levels of phosphorus supplementation of beef cows at Armoedsvlakte. 1984. M.V.P. Read

V.5311/05/1/4: Large stock: dry matter intake of beef cattle on veld at Glen. 1969. E.A.N. Engels

V.5311/05/1/6: Large stock: the influence of rate of fermentation in the rumen on voluntary intake from the pasture by beef cattle on veld of Armoedsvlakte. 1987. M.L. Jonker

V.5311/05/1/7: Large stock: the influence of rate of fermentation in the rumen on voluntary intake from the pasture by beef cattle on veld of Vaalharts. 1988. M.C. Basson

V.5311/05/1/8: Large stock: the influence of rate of fermentation in the rumen on voluntary intake from the pasture by beef cattle on veld of Glen. 1987. H.O. de Waal

V.5311/05/2/1: Large stock: the application of cultivated roughages for milk production at Glen. 1978. S.W. Matthee

V.5311/05/2/2: Large stock: the influence of frequency of concentrate feeding on the utilisation of roughage by dairy cows at Glen. 1983. S.W. Matthee

V.5311/05/2/3: Large stock: the evaluation of annual rye grass for milk production at Glen. 1985. S.W. Matthee

W.5311/05/1/1: Cultivated kikuyu pastures as a source of food for dairy cows in the Winter Rainfall Region. 1980. P.J. Swart

W.5311/05/2/1: The substitution of lucerne hay with ammoniated wheat straw as the roughage component in the rations of lactating dairy cows in the Winter Rainfall Region. 1984. E.D. D'Hangest D'yvoy

W.5311/05/2/2: Large stock: the substitution of oat hay with ammoniated wheat straw in growth rations for dairy breed heifers in the winter rain cropping area. 1984. E.D. D'Hangest D'yvoy

W.5311/05/3/1: The economic implications of concentrate and hay supplementation of dairy cows on artificial pastures. 1984. C.J.C. Muller

W.5311/05/3/2: Large stock feeding: an economic evaluation of milk production with Jersey cows on established pasture with and without concentrate and hay supplementations and a zero-grazing system in the Winter Rainfall Region. 1987. C.J.C. Muller

- *Upgrading/Veredeling*

D.5311/07/1/1: Large stock: upgrading of the Edelheer and Roodebos Bonsmara breed strains in the high rainfall sourveld area. 1980. A.J. Fourie

D.5311/07/1/2: Large stock: performance testing of bulls from the Edelheer and Roodebos Bonsmara strains in the high rainfall sourveld area. 1980. J.P. Compaan

H.5311/07/1/1: Large stock: the influence of genetic and environmental factors on production traits of an Afrikaner cattle herd. 1983. J.J. Viljoen

H.5311/07/1/2: Large stock: the influence of genetic and environmental factors on production traits of a Simmentaler cattle herd. 1986. J.J. Viljoen

T.5311/07/1/1: Large stock: the comparison of pure and cross-bred beef cattle in different breeding systems for the sweet bushveld. 1965. C.J.F. Lüdemann

T.5311/07/1/2: Large stock: development and improvement of the Edelheer, Roodebos and Wesselsvlei breeding lines of the Bonsmara beef cattle race in the sour mixed bushveld at Roodeplaat. 1971. G. Marincowitz

V.5311/07/1/1: Large stock: the use of different beef breeds as sires and dams in pure- and cross-breeding systems at Vaalharts. 1974. D.L. Els

V.5311/07/1/2: Large stock: cross-breeding with the Afrikaner dam as basis with different large frame breeds under semi-intensive conditions at Vaalharts. 1973. D.L. Els

V.5311/07/1/3: Large stock: the production potential of female crosses from Afrikaner cows with different large frame beef breeds at Vaalharts. 1976. D.L. Els

V.5311/07/1/4: Large stock: the evaluation of the Belmont Red and Bonsmara beef breeds under extensive conditions at Vaalharts. 1982. D.L. Els

V.5311/07/1/5: Large stock: the development and upgrading of the Wesselsvlei strain at Armoedsvlakte. 1980. D.L. Els

V.5311/07/1/6: Large stock: the upgrading of Belmont Red halve crosses to an additional Bonsmara breeding line. 1986. H.S. Pottas

• *Management/Bestuur*

N.5311/41/1/3: Large stock: effect of winter growth levels and stocking rates on the highland sourveld on the development of beef cattle heifers. 1981. A. van Niekerk

N.5311/41/1/4: Large stock: effect of stocking rate on the fertility and performance of beef cattle and the veld in the highland sourveld, 4f, of Natal. 1984. A.D. Lyle

N.5311/41/1/5: The influence of stocking rate on veld on the performance of the beef cow herd in the sandy sourveld areas at Dundee. 1987. J.S. Crichton

N.5311/41/2/1: Large stock: performance of dual purpose and British beef cattle on kikuyu pasture in the high rainfall sourveld area at Cedara. 1975. B.P. Louw

N.5311/41/2/2: Large stock: beef production on *A. macrum* and *D. eriantha* in bioclimatic region 8 of the high rainfall sourveld. 1983. A.P. van Schalkwyk

N.5311/41/2/4: Large stock: the influence of weaning age and pasture management system on cow and calf performance on kikuyu in the high rainfall sourveld areas at Cedara. 1986. B.P. Louw

N.5311/41/2/5: Large stock: the influence of wintering level and stocking rate on the performance of yearling steers on kikuyu in the high rainfall sourveld areas at Cedara. 1986. B.P. Louw

N.5311/41/2/6: Large stock: characterisation of *D. eriantha* pasture during the growing season for beef production in bioclimatic region 8 of the high rainfall sourveld. 1987. A.P. van Schalkwyk

N.5311/41/2/7: Characterisation of *A. macrum* pasture during the growing season for beef production in bioclimatic region 8 of the high rainfall sourveld. 1987. A.P. van Schalkwyk

N.5311/41/3/2: Large stock: databank for the dairy herd on Cedara. 1981. T.J. Dugmore

T.5311/41/1/1: Large stock: beef cattle production on natural pasture supplemented with *Cenchrus ciliaris* on the Springbok Flats. 1973. G. Marincowitz

T.5311/41/1/2: Large stock: a stable beef cattle production system for Mopani veld. 1968. C.J.F. Lüdemann

T.5311/41/1/3: Large stock: the potential and profit margins of weaner, tollie and ox production systems in the bushveld. 1963. C.J.F. Lüdemann

V.5311/41/1/1: Large stock: an investigation of the seasonal trend of milk production and the effect of calving date on production on certain selected farms. 1984. J.P. Lessing

W.5311/41/1/1: Large stock: evaluation of shelters for dairy cows in the Winter Rainfall Region. 1981. C.J.C. Muller

W.5311/41/1/2: Large stock: the determination of the effect of a shade structure in open camps on the milk and reproduction parameters of lactating dairy cows in the Winter Rainfall Region. 1985. C.J.C. Muller

W.5311/41/1/3: Large stock: the evaluation of semi-intensive housing systems with reference to micro-climate, height of roof and insultation for lactating dairy cows in the Winter Rainfall Region. 1985. C.J.C. Muller

W.5311/41/2/1: Large stock: the determination of the mastitis incidence using a fossomatic somatic cell counter and its value in mastitis management programmes in dairy cattle in the Winter Rainfall Region. 1984. J.G. Conradie

SMALL STOCK/KLEINVEE

• *Reproduction/Reproduksie*

T.5312/04/1/1: Small stock: effect of energy, protein and NPN on the fertility of mutton sheep ewes. 1970. G. Marincowitz

T.5312/04/2/1: Small stock: the sexual activity of Merino woolled sheep and their crosses. 1973. L. Ueckermann

V.5312/04/1/3: Small stock: the influence of body mass on reproduction of the Karakul ewe at the Karakul Research Station. 1985. A.S. Faure

W.5312/04/1/1: Small stock: reproduction - estrogenic activity of pasture legumes in the Winter Rainfall Region. 1986. N.M. Kritzinger

• *Nutrition/Voeding*

D.5312/05/1/1: Small stock: the relationship in the seasonal variation in the beta carotene of sourveld and the beta carotene levels of blood plasm in woolled sheep. 1983. P.J.L. Zeeman

D.5312/05/1/2: Small stock: the influence of beta carotene supplementation on the reproduction of lactating ewes. 1983. J.A. Erasmus

D.5312/05/1/3: Small stock: the influence of stocking rate, whole grain feeding and rumen buffers on the production response of ewes and lambs in the sourveld. 1983. W.P. Henning

D.5312/05/1/4: Small stock: the influence of winter stress on the production response of Merino wethers. 1985. H.H. Barnard

D.5312/05/1/5: Small stock: the influence of reproduction on the diet selection of woolled sheep grazing high rainfall sourveld. 1983. P.J.L. Zeeman

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D.5312/05/2/2: Small stock: the influence of reproduction and veld condition on diet selection by Boer goats grazing Valley Bushveld. 1986. P.J.L. Zeeman

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• *Potential studies/Potensiaalstudies*

V.5312/36/1/1: Small stock: the influence of stocking rate on wool production on veld at Glen. 1985. C.J. Louw

• *Management/Bestuur*

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K.5312/52/1/1: Small stock: investigation of weathering of wool in the Karoo Region. 1976. P.D. Grobbelaar

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GAME/WILD

- *Nutrition/Voeding*

D.5313/05/1/1: Game: diet selection and intake patterns of kudu and bush buck on valley bushveld. 1986. P.J.L. Zeeman

- *Ecology/Ekologie*

T.5313/27/1/1: A survey of veld condition, game condition and game stocking rates on a number of farms in the Mopanieveld. 1986. D.D. Snyman

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Non-ruminants/Nie-herkouers

OSTRICHES/VOLSTRUISE

- *Reproduction/Reproduksie*

W.5321/04/1/1: The effect of seasons and rest periods on the reproduction performance of ostriches in the Karoo and arid areas in the Winter Rainfall Region. 1984. D. Swart

- *Nutrition/Voeding*

W.5321/05/1/1: Finishing of slaughter ostriches for optimal leather production above 75 kg live mass. 1984. D. Swart

W.5321/05/1/2: The use of metabolisable energy (ME) as a measurement to evaluate feedstuffs for ostriches in the Karoo and arid area of the Winter Rainfall Region. 1985. D. Swart

- *Upgrading/Veredeling*

W.5321/07/1/1: Genetic parameters for production and reproduction traits of the ostrich flock at Oudtshoorn Experiment Farm. 1974. D. Swart

- *Management/Bestuur*

W.5321/41/1/1: Ostriches: the micro habitat of ostrich eggs during natural incubation in nests and under conditions of artificial incubation in the Karoo and arid areas of the Winter Rainfall Region. 1984. D. Swart

W.5321/41/2/1: Ostriches: a comparison between meal feeding and meal feeding plus irrigated pastures in rearing systems for ostrich chicks. 1984. D. Swart

W.5321/41/3/1: Testing of chicken shelters for semi-intensive rearing of ostrich chickens in the Karoo and arid areas. 1982. D. Swart

• *Nutrition/Voeding*

W.5322/05/1/1: Evaluation of barley as feed source in pig diets in the Winter Rainfall Region. 1983. R.C. Olckers

RESOURCE UTILISATION RESEARCH (PASTURES) HULPBRONBENUTTINGSNAVORSING (WEIDING)

Pasture/Weiding

VELD

• *Taxonomy/Taksonomie*

D.5411/01/1/1: Veld: reference herbaria at Dohne. 1976. M.G. McMaster

V.5411/01/1/1: Veld: the collection, identification and mountings of plants found in the Free State Region for the establishment of a herbarium at Glen. 1952. A.F.J. Visagie

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D.5411/03/1/1: Veld: carbohydrate accumulation and depletion patterns in key grass species of the central grassveld in the Eastern Cape. 1980. J.E. Danckwerts

D.5411/03/1/2: Veld: crop growth rate of key grass species of the central grassveld in the Eastern Cape. 1980. J.E. Danckwerts

D.5411/03/1/3: Veld: effect of seasonality and plant age on the net assimilation rate of key grass species in the Eastern Cape. 1980. J.E. Danckwerts

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D.5411/03/1/5: Veld: carbohydrate replenishment in *Acacia karroo* following defoliation in the central grassveld of the Eastern Cape. 1982. W.R. Teague

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D.5411/03/1/7: Veld: the effect of defoliation on the root/shoot balance of *A. karroo* in the central grassveld areas of the Eastern Cape. 1984. W.R. Teague

V.5411/03/1/1: Veld: a study of the carbohydrate status of the different plant parts of *Rhigozum trichotomum* during the season in a natural habitat at the Karakul Research Station. 1984. A. Moore

V.5411/03/1/2: Veld: the characterisation of the pattern of photosynthesis and transpiration of *Rhigozum trichotomum* as influenced by light, water and temperature under veld conditions at Upington. 1985. A. Moore

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T.5411/05/1/1: Veld: fertiliser trial on veld pastures. 1949. G.T. Rootman

• *Pests/Plae*

T.5411/20/1/1: Veld: the incidence and influence of harvester termites on natural grazing pastures in the bushveld. 1983. H.H. Gouse

T.5411/20/1/2: Veld: a study of the occurrence of the harvester termite in the Transvaal Region. 1985. H.H. Gouse

T.5411/20/1/3: Veld: a study of the influence of soil moisture and availability of dry food on populations of harvester termites in the bushveld. 1985. H.H. Gouse

V.5411/20/1/1: Veld: a study of the harvester termite (*Hodotermes mossambicus*) on veld under different management systems at Glen. 1984. Susanna W. Mostert

V.5411/20/1/2: Veld: a study of the harvester termite (*Hodotermes mossambicus*) on veld under different veld management systems at Armoedsvlakte. 1984. Susanna W. Mostert

• *Chemical control/Chemiese beheer*

V.5411/21/1/1: Veld: a study of the effect of Graslan on the vegetation of the Thorn Bushveld of the Northern Cape at De Woud. 1983. A. Moore

V.5411/21/1/2: Veld: a study of more economical and selective aerial applications of Graslan for the control of *Acacia mellifera* and associated woody invader plants in the Northern Cape at Duncan. 1984. A. Moore

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D.5411/27/1/2: Veld: mortality and heterotrophic consumption of *Acacia karroo* leaves in the central grassveld areas. 1982. W.R. Teague

H.5411/27/1/1: Veld: the botanical composition of the vegetation on different veld units. 1983. R.H. Drewes

H.5411/27/1/2: Veld: plant species preference of cattle on different veld units. 1983. A.S. de Beer

H.5411/27/1/3: Veld: growth curves of certain preferred grasses on different veld units. 1986. S.L. van Schalkwyk

H.5411/27/1/4: Veld: patterns of plant succession on different veld units. 1983. S.L. van Schalkwyk

H.5411/27/2/1: Veld: quantitative characterisation of veld ecotopes in the Highveld Region. 1984. R.H. Drewes

T.5411/27/1/1: Veld: second succession on bare Mopani veld pastures. 1964. G.T. Rootman

V.5411/27/1/1: Veld: a study of the influence of *Rhigozum trichotomum* (driedoring) on other plants in a natural habitat at the Karakul Research Station. 1983. A. Moore

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• *Crop science/Gewaskunde*

D.5411/30/1/3: Veld: growth patterns of *Acacia karroo* in the central grassveld areas of the Eastern Cape. 1982. W.R. Teague

D.5411/30/1/4: Veld: the effect of different intensities of defoliation at different phenological stages on the central growth of *Acacia karroo* in the central grassveld areas of the Eastern Cape. 1982. W.R. Teague

D.5411/30/1/5: Veld: the effect of different frequencies and intensities of defoliation under a wet and dry moisture regime on the above-ground parts of *Acacia karroo* in the central grassveld areas of the Eastern Cape. 1982. W.R. Teague

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T.5411/30/1/1: Veld: fertilisation of veld pastures in the north-eastern mountain sourveld. 1969. B.H. Beukes

T.5411/30/1/2: Veld: growth and development of *Diheteropogon amplectans* and *Eulalia villosa* in veld pastures. 1973. G.D. Kotze

T.5411/30/2/1: Veld: fertilisation of veld pastures in the north-eastern highveld. 1969. C.C. de Witt

T.5411/30/2/2: Veld: influence of fertilisation and paraquat on the nutritional value of veld pastures. 1973. G.D. Kotze

• *Water requirements/Waterbehoeftes*

D.5411/31/1/1: Veld: water requirements and utilisation of *Acacia karroo* and key grass species during different times of the year in relation to their production. 1982. G.C. Stuart-Hill

D.5411/31/1/2: Veld: water stress and the growth of *Acacia karroo* in the central grassveld areas of the Eastern Cape. 1982. W.R. Teague

D.5411/31/1/3: Veld: the effect of water stress on the rate of photosynthesis and root/shoot balance following defoliation of *Acacia karroo* in the central grassveld of the Eastern Cape. 1984. W.R. Teague

D.5411/31/1/4: Veld: water use by *A. karroo* as influenced by defoliation. 1984. W.R. Teague

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W.5412/41/1/2: The evaluation and seed multiplication of natural pastures species at the Oudtshoorn Experiment Farm for planting in the Klein Karoo subregion. 1985. S.A. Barnard

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D.5413/05/1/1: Cultivated pasture: the yield of Rhodes grass at various nitrogen and phosphate levels at Bathurst. 1981. C.J.G. le Roux

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V.5414/20/1/1: Lucerne: investigation on the occurrence and distribution of the white fringed beetle on lucerne in the Lower Orange River irrigation area. 1985. J. de Jager

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D.5414/30/1/1: Evaluation of improved lucerne cultivars for the high rainfall sourveld areas of the Eastern Cape at Dohne. 1986. G.R. Barnes

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RESOURCE UTILISATION RESEARCH (FARMING SYSTEMS) HULPBRONBENUTTINGSNAVORSING (BOERDERYSTELSELS)

Farming enterprises/Boerderyvertakkings

STOCK AND GAME FARMING/VEE- EN WILDBOERDERY

• *Potential studies/Potensiaalstudies*

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AGRICULTURAL PRODUCTION ECONOMICS RESEARCH
LANDBOUPRODUKSIE-EKONOMIENAVORSING

Macro resource economics/Makrohulpbronekonomie

PRODUCTION FACTOR STUDIES/PRODUKSIEFAKTORSTUDIES

• *Production economics/Produksie-ekonomie*

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Farm business management/Plaasbedryfsleer

BUSINESS RESULTS/BEDRYFSRESULTATE

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ENTERPRISE RELATIONSHIPS/BEDRYFSVERHOUDINGS

- *Production economics/ Produksie-ekonomie*

PE.5623/48/1/2: Enterprise relationship: economical research in respect of the control of false codling moth on citrus in the winter rain cropping area. 1981. J.M. van Zyl

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PE.5623/48/2/2: Enterprise relationship: the introduction of long-term pasture crops in sheep production systems in the central grassveld of the Free State Region. 1982. A. de K. Marais

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PE.5623/48/4/1: Enterprise relationship: wintering of woolled sheep and other livestock in the northern Drakensberg grazing region. 1982. D.C. du Toit

PE.5623/48/4/3: Enterprise relationship: the influence of different feeding strategies on the economic efficiency of beef cattle in the summer rain cropping areas. 1983. J. Hough

PE.5623/48/4/4: Enterprise relationship: research in respect of the economic advantages of conservation tillage in the summer rain cropping area of Western Transvaal and North-western Free State. 1983. J. Hough

PE.5623/48/4/5: An economic analysis of dairy enterprises and their financial roles in the farming structure of mixed farming in the summer rain cropping area. 1984. P.J. Cornelius

PE.5623/48/4/6: Enterprise relationship: a comparison of margins among weaner, tollie and ox production systems in the bushveld of Northern Transvaal. 1984. D.C. du Toit

PE.5623/48/4/7: Enterprise relationship: strategy for production continuation and renewal of citrus and subtropical orchards in the bushveld area. 1984. D.C. du Toit

PE.5623/48/4/8: Enterprise relationship: an economic evaluation of milk and beef production of Simmentalers on natural veld and dryland - *Cenchrus* pasture on the Springbok Flats of Transvaal. 1984. P.J. Cornelius

PE.5623/48/4/9: Enterprise relationship: the economic evaluation of the RHFA concept with respect to the minimising of risk and the determination of land values. 1986. J.J. de Bruyn

PE.5623/48/4/10: Enterprise relationship: the influence of different feeding strategies on the economic efficiency of small stock farming in the summer rain cropping areas. 1986. P.F. du Plessis

SOIL CONSERVATION RESEARCH/GRONDBEWARINGSNAVORSING

Soil conservation/Grondbewaring

EROSION/EROSIE

- *Situation analysis/Situasiebepalings*

V.5711/35/1/1: Erosion: investigation of the functional efficiency of subsidised waterways in the middle Free State subregion. 1985. S.J. van Reenen

• *Conservation studies/Bewaringstudies*

D.5711/38/1/1: Erosion: the determination of soil losses associated with various tillage practices on various soil series established to pineapples in the East London district. 1982. C.J. Bradfield

D.5711/38/1/2: Erosion: the determination of soil losses associated with various tillage practices and land use on soil series at Alexandria. 1983. P.C. Griffiths

D.5711/38/2/1: Erosion: the effect of small structures in eroded watercourses in the high rainfall sourveld. 1983. B.I. Hill

D.5711/38/2/2: Erosion: the effect of various small structures in eroded watercourses in the high rainfall sourveld. 1985. E. Marx

D.5711/38/2/3: Erosion: the effect of small structures in eroded watercourses in the bushveld areas. 1984. G.M. Bicknell

N.5711/38/1/1: Erosion studies using natural run-off plots. 1985. R.P. Simms

N.5711/38/1/2: Studies using a rainfall simulator and natural run-off plots to quantify soil losses from veld. 1982. R.P. Simms

N.5711/38/1/3: Erosion and run-off studies on pineapple lands in Zululand. 1987. W.B. Russell

V.5711/38/1/1: Erosion: investigation of adapted grass covers for waterways in RHFA 4053. 1985. P.J. Knoester

V.5711/38/2/1: Erosion: water run-off control planning of the Immigrant area in the Petrusburg Extension Ward. 1985. F.J. Smit

V.5711/38/2/2: Erosion: water run-off control planning of subcatchment area 3 of the Korannaberg catchment area in Excelsior district in the Brandfort Extension Ward. 1985. S.J. van Reenen

V.5711/38/2/3: Erosion: water run-off control planning of the Rondas area in the Brandfort Extension Ward. 1986. C.S. van Niekerk

V.5711/38/2/4: Erosion: water run-off control planning of the Spioenheuwel area in the Boshof district in the Kimberley Extension Ward. 1987. J.H. Mulder

V.5711/38/3/1: Erosion: investigation of the functional efficiency of different types of small conservation structures in eroded areas in dongas and gullies in the Edenburg Extension Ward. 1985. S. Brink

V.5711/38/3/2: Erosion: investigation of the functional efficiency of different types of small conservation structures in dongas and gullies in the Postmasburg Extension Ward. 1985. J. Weyers

• *Engineering/Ingenieurskunde*

LI.5711/51/1/1: Engineering aspects of soil erosion: aspects of gully erosion. 1983. P.J. Strumpher

LI.5711/51/1/2: Engineering aspects of soil erosion: aspects regarding soil losses. 1983. P. McPhee

DRAINAGE/DREINERING

• *Agrohydrology/Agrohidrologie*

V.5712/34/1/1: The planning and implementation of drainage systems on waterlogged and salinisated irrigation lands in the Vaalharts irrigation area. 1985. J.H. Mulder

V.5712/34/1/2: The planning and implementation of drainage systems on waterlogged and salinisated irrigation lands in the Douglas Extension Ward. 1985. J.H. Mulder

RESOURCE CONSERVATION/HULPBRONBEWARING

Planning of areas/Beplanning van gebiede

FARM PLANNING/PLAASBEPLANNING

- *Agrohydrology/Agrohidrologie*

N.5831/34/1/1: Farm planning: run-off control planning in the Howick Extension Ward. 1979. M.G. Price

N.5831/34/1/2: Farm planning: run-off control planning in the Greytown Extension Ward. 1979. R.C. Richardson

N.5831/34/1/3: Farm planning: run-off control planning in the Ixopo Extension Ward. 1979. A.D. Simpson

N.5831/34/1/4: Farm planning: run-off control planning in the Pongola Extension Ward. 1979. A.D. Robinson

N.5831/34/1/5: Farm planning: run-off control planning in the Kokstad Extension Ward. 1979. D.B. Austin

N.5831/34/1/6: Farm planning: run-off control planning in the Richmond Extension Ward. 1979. E.M.F. McAllister

N.5831/34/1/7: Farm planning: run-off control planning in the Newcastle Extension Ward. 1979. M.P. Wentzel

N.5831/34/1/8: Farm planning: run-off control planning in the Vryheid Extension Ward. 1979. R.J. Dicks

N.5831/34/1/9: Farm planning: run-off control planning in the Estcourt Extension Ward. 1979. S.K. Armour

N.5831/34/1/10: Farm planning: run-off control planning in the Dundee Extension Ward. 1979. P.P. Kloppers

N.5831/34/1/11: Farm planning: run-off control planning in the Pietermaritzburg Extension Ward. 1979. P.J.D. Nicholson

N.5831/34/1/12: Farm planning: run-off control planning in the Ladysmith Extension Ward. 1979. K.W. Watkinson

- *Management/Bestuur*

D.5831/41/1/1: Planning of farms within the Alexandria magisterial district to promote the efficient conservation of natural resources. 1984. P.C. Griffiths

D.5831/41/1/2: Planning of farms with regard to veld utilisation and resource conservation within the Elliot Extension Ward to promote the efficient utilisation and conservation of natural resources. 1985. E. Marx

D.5831/41/1/3: Farm planning within the Barkly East Extension Ward to promote efficient utilisation and conservation of natural resources. 1985. J.S.J Jordaan

D.5831/41/1/4: Farm planning of farms within the Adelaide Extension Ward to promote efficient utilisation and conservation of natural resources. 1985. G.M. Bicknell

D.5831/41/1/5: Planning of farms within the Bathurst magisterial district to promote the efficient utilisation and conservation of natural resources. 1985. D.L. Palmer

D.5831/41/1/6: Planning of farms within the Tarkastad magisterial district to promote the efficient utilisation and conservation of agricultural resources. 1983. W.J.M. Els

D.5831/41/1/7: Planning of farms in the Komga magisterial district to promote the efficient utilisation and conservation of the natural resources. 1984. C.J. Bradfield

D.5831/41/1/8: Planning of farms in the Stutterheim Extension Ward to promote the efficient utilisation and conservation of the natural resources. 1984. B.I. Hill

D.5831/41/1/9: Planning of farms within the Sterkstroom magisterial district to promote the efficient utilisation and conservation of the natural resources. 1983. J.H. Fourie

D.5831/41/1/10: Planning of farms within the Albany magisterial district to promote efficient utilisation and conservation of natural resources. 1986. W.J. Penny

D.5831/41/1/11: Planning of farms with regard to veld utilisation and resource conservation within the Humansdorp Extension Ward to promote the efficient utilisation and conservation of natural resources. 1985. J.P. van Zyl

D.5831/41/1/12: Planning of farms within the Molteno magisterial district (Dordrecht Extension Ward) to promote efficient utilisation and conservation of the natural resources. 1985. J.C. van der Walt

D.5831/41/1/13: Planning of farms within the Uitenhage and Kirkwood magisterial districts to promote the efficient utilisation and conservation of the natural resources. 1985. C.S. van R. Müller

D.5831/41/1/14: Planning of farms within the Queenstown magisterial district to promote the efficient utilisation and conservation of the natural resources. 1983. W.J.M. Els

D.5831/41/1/15: Planning of farms in the Port Elizabeth magisterial district of the eastern seaboard area. 1986. R.P. Laing

D.5831/41/1/16: Planning of farms within the Aliwal North Extension Ward to promote efficient utilisation and conservation of the natural resources. 1985. D.T. Bezuidenhout

D.5831/41/2/1: Run-off control planning of farms in the sub-catchment area No. 10900104 in the Humansdorp Extension Ward. 1984. J.P. van Zyl

D.5831/41/2/2: Run-off control planning of farms in the Zuney Valley, sub-catchment area No. 14200200. 1984. P.C. Griffiths

D.5831/41/2/3: Farm planning: area run-off control planning in catchment areas No. 041308, 041309 and 041312 within the Barkly East Extension Ward. 1985. J.S.J. Jordaan

D.5831/41/2/4: Farm planning: area run-off control planning in sub-catchment No. 17500400 in the Elliot Extension Ward. 1985. E. Marx

D.5831/41/2/5: Run-off control planning of farms in the Baviaans River catchment area - drainage region No. 1560 - Bedford magisterial district. 1985. G.M. Bicknell

D.5831/41/2/6: Area run-off control planning of farms in the Elands River Valley sub-catchments Nos 12100100 and 11700300. 1985. C.S. van R. Müller

D.5831/41/2/7: Farm planning: stabilising of eroded watercourses in upper Heuningklip River - sub-catchment area 1730/02/04. 1983. J.E. Aspinall

D.5831/41/2/8: Farm planning: run-off control planning in a portion of the sub-catchment area No. 04130500 (Bossielaagte) situated in the Lady Grey magisterial district. 1985. D.T. Bezuidenhout

D.5831/41/2/9: Water run-off control planning of farms in the area demarcated as Upper-Coerney, sub-catchment No. 13401501 in the Paterson area. 1985. R.P. Laing

D.5831/41/2/11: Area run-off control planning of farms in the Buyskloof Valley, sub-catchment No. 14200100, in the eastern seaboard area. 1986. P.C. Griffiths

D.5831/41/2/12: Farm planning: maintenance and improvement of existing run-off control plans on cultivated lands in the catchment areas Nos 041308, 041309 and 041312 within the Barkly East Extension Ward. 1985. J.S.J. Jordaan

D.5831/41/2/13: Farm planning: run-off control planning in the sub-catchment area 1543-01-01 (Vrolikskraal) situated in the Molteno magisterial district. 1985. J.C. van der Walt

D.5831/41/2/14: Farm planning: water run-off control - improvement and maintenance of existing contour systems in the Elands River catchment area. 1986. I.D. Barlow

D.5831/41/2/15: Farm planning: stabilising of eroded watercourses in Bamboeshoek, sub-catchment area No. 1730/02/01. 1984. J.H. Fourie

D.5831/41/2/16: Area run-off control planning of farms in the sourveld area in the Humansdorp Extension Ward of the Karoo and arid areas. 1986. E.C. Kieck

D.5831/41/2/17: Area run-off control planning of farms in the Upper Krom River area in the Humansdorp Extension Ward of the eastern seaboard area. 1986. E.C. Kieck

D.5831/41/2/18: Farm planning: area run-off control planning of irrigation lands in the Hankey magisterial district. 1986. R.P. Laing

D.5831/41/2/19: Water run-off control planning of all pineapple farms in the East London Extension Ward. 1985. I.D. Scholtz

D.5831/41/2/20: Farm planning: area run-off control planning of irrigation in the proposed Kabeljou irrigation area in the Humansdorp magisterial district. 1987. E.C. Kieck

ENTREPRENEUR DEVELOPMENT
ONDERNEMERSONTWIKKELING

EXTENSION SCIENCE INVESTIGATIONS
VOORLIGTINGKUNDIGE ONDERSOEKE

Resources and technology/Hulpbronne en tegnologie

MANAGEMENT FACTORS/BESTUURSFAKTORE

- *Persuasion/Oorreding*

T.6114/39/1/1: Management factors: the persuasion of farmers to optimal resource utilisation in the Lowveld area of the Transvaal Region. 1978. I.J. van Rensburg

T.6114/39/1/5: Management factors: the persuasion of farmers to optimal resource utilisation in the Koedoesrand area of northern Transvaal in the Transvaal Region. 1976. S.W. Burger

T.6114/39/2/3: Management factors: the persuasion of farmers to optimal resource utilisation in the Lowveld area. 1977. P.J. du Toit

MAN/MENS

- *Situation analysis/Situasiebepaling*

H.6115/35/1/1: Factors that influence the under-achievement of first-year students at Potchefstroom College of Agriculture. 1983. L.I. de Waal

- *Persuasion/Oorreding*

K.6115/39/1/1: Man: persuasion of putative tresspassers of the Agricultural Resources Act in the Cradock Extension Ward. 1985. P.S. van Heerden

K.6115/39/1/2: Man: persuasion of putative tresspassers of the Agricultural Resources Act in the Graaff-Reinet Extension Ward. 1985. J.G. Theron

K.6115/39/1/3: Man: persuasion of putative tresspassers of the Agricultural Resources Act in the Middelburg Extension Ward. 1985. J.D. Blom

- *Extension science/Voorligtingkunde*

H.6115/40/2/1: Man: study group participation to agricultural development in the Lichtenburg subregion. 1985. M.M. Grobbelaar

N.6115/40/1/1: Human potential in relation to optimum land use of farmers in the Underberg Extension Ward. 1974. D.M. Rix

RUN-OFF CONTROL/AFLOOPBEHEER

- *Agrohydrology/Agrohidrologie*

T.6118/34/1/2: Run-off control on the north-eastern Springbok Flats of the Northern Transvaal area. 1984. J. Bellingham

T.6118/34/1/3: Run-off control in the north-eastern area of the Transvaal Region. 1976. J.C. Mouton

T.6118/34/1/4: Run-off control in the Middle Transvaal Groot Olifants area of the Transvaal Region, area 02. 1979. K.P. de Beer

T.6118/34/1/5: Run-off control in the Annysspruit area of the south-eastern Transvaal extension area. 1975. J.C. Mouton

T.6118/34/1/6: Run-off control in the Klein Komati area of the south-eastern Transvaal. 1975. J.C. Mouton

T.6118/34/1/10: Run-off control: the design of a water run-off control system in the Bokpoort target area in Potgietersrus. 1975. J. Bellingham

T.6118/34/1/11: Run-off control: the design of a water run-off control system for the Strydom block area - Lowveld, Komatipoort. 1975. M.V. Wattrus

T.6118/34/1/12: Run-off control in the Sabie Valley area - the design of a water run-off control system in the Sabie Valley, Witrivier. 1975. M.V. Wattrus

T.6118/34/2/1: Run-off control in the Badplaaskom area of the south-eastern Transvaal area of the Transvaal Region. 1975. J.C. Mouton

COMMUNICATION/KOMMUNIKASIE

- *Extension science/Voorligtingkunde*

N.6119/40/1/1: The use of agricultural literature in communicating information to farmers in the Natal Region. 1982. Marion A. Abbott

W.6119/40/1/1: Communication: an extension science investigation into the effectiveness of the table grape block competition in the Hex River Valley. 1985. G.G. van der Merwe

PROGRAMMED EXTENSION/GEPROGRAMMEERDE VOORLIGTING

Resource utilisation/Hulpbronbenutting

STOCK AND GAME FARMING/VEE- EN WILDBOERDERY

- *Evaluation/Evaluasie*

D.6211/37/1/1: Stock and game farming: to demonstrate the utilisation and control of tree and shrub species in the humid grass/bush communities of the Bathurst Extension Ward. 1987. P.G. King

- *Persuasion/Oorreding*

D.6211/39/1/1: Stock and game farming: the persuasion of farmers to promote optimal pasture utilisation and animal production in the Queenstown Extension Ward. 1984. L.P.J. Swart

D.6211/39/1/2: Stock and game farming: the persuasion of farmers to promote optimal pasture utilisation and animal production in the Bedford magisterial district. 1986. J.B. Marais

D.6211/39/1/3: Stock and game farming: the persuasion of farmers to promote optimal pasture utilisation and animal production in the Albany magisterial district. 1986. J.L. Clacey

D.6211/39/1/4: Stock and game farming: to train farmers in the Adelaide and Bedford magisterial districts to subjectively assess veld condition in the False Thornveld. 1987. J.B. Marais

D.6211/39/1/5: Stock and game farming: the persuasion of farmers to promote optimal pasture utilisation and animal production in the Alexandria Extension Ward. 1986. A.E. du Plessis

D.6211/39/1/6: Stock and game farming: training of collaborators and extension officers in the Eastern Cape Region to achieve optimum milk production. 1986. P.J. Olivier

D.6211/39/1/8: Stock and game farming: persuasion of farmers in the Port Elizabeth Extension Ward to achieve optimum pasture and animal production. 1987. J.B.C. Kilfoil

D.6211/39/1/9: Stock and game farming: training of farmer collaborators and extension staff in the Eastern Cape Region to promote optimum small stock production. 1987. J.C. Scheltema

D.6211/39/1/10: Stock and game farming: the persuasion of farmers in the Thomas River conservation district to control and eridicate silver and black wattle. 1986. A.M. Grenfell

D.6211/39/1/11: Stock and game farming: the persuasion of farmers to promote optimal pasture utilisation and animal production in the Stutterheim Extension Ward. 1986. A.M. Grenfell

D.6211/39/2/1: Stock and game farming: promotion of adapted stock farming in the Valley Bushveld of the Uitenhage Extension Ward. 1984. L.O. Grobler

K.6211/39/1/1: Stock and game farming: persuasion of farmers to apply the group camp approach of veld management in the Extension Ward of Graaff-Reinet. 1985. J.G. Theron

K.6211/39/1/2: Stock and game farming: persuasion of farmers to apply the group camp approach of veld management in the Cradock Extension Ward. 1985. P.S. van Heerden

K.6211/39/1/3: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the Burgersdorp Extension Ward. 1985. W.V.D. Botha

K.6211/39/1/4: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the Colesberg Extension Ward. 1985. M. van Niekerk

K.6211/39/1/5: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the De Aar Extension Ward. 1985. W.H. van Staden

K.6211/39/1/6: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the Middelburg Extension Ward. 1985. J.D. Blom

K.6211/39/1/7: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the Calvinia Extension Ward. 1985. N. Nortje

K.6211/39/1/8: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the Carnarvon Extension Ward. 1985. G.Z.J. Barnard

K.6211/39/1/9: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the Kenhardt Extension Ward. 1985. J.J. Zandberg

K.6211/39/1/10: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the Prieska Extension Ward. 1985. D.J. Roux

K.6211/39/1/11: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management, Beaufort West Extension Ward. 1986. A.J. Wiid

K.6211/39/1/12: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management, Fraserburg Extension Ward. 1986. I.J. van der Merwe

K.6211/39/2/1: Stock and game farming: persuasion of farmers to introduce drought fodder crops in the farming systems in the Graaff-Reinet Extension Ward. 1984. J.G. Theron

K.6211/39/2/2: Stock and game farming: persuasion of farmers to establish drought fodder crops in the Colesberg Extension Ward. 1985. M. van Niekerk

K.6211/39/2/3: Stock and game farming: persuasion of farmers to establish drought fodder crops in the De Aar Extension Ward. 1985. W.H. van Staden

K.6211/39/2/4: Stock and game farming: persuasion of farmers to establish drought fodder crops in the Middelburg Extension Ward. 1985. J.D. Blom

K.6211/39/2/5: Stock and game farming: persuasion of farmers to introduce drought fodder crops in the farming systems in the Calvinia Extension Ward. 1985. N. Nortje

K.6211/39/2/6: Stock and game farming: persuasion of farmers to introduce drought fodder crops in the farming systems in the Carnarvon Extension Ward. 1985. G.Z.J. Barnard

K.6211/39/2/7: Stock and game farming: persuasion of farmers to introduce drought fodder crops in the farming systems in the Kenhardt Extension Ward. 1985. J.J. Zandberg

K.6211/39/2/8: Stock and game farming: persuasion of farmers to introduce drought fodder crops in the farming systems in the Prieska Extension Ward. 1985. D.J. Roux

K.6211/39/2/9: Stock and game farming: persuasion of farmers to plant drought fodder crops, Beaufort West Extension Ward. 1986. A.J. Wiid

K.6211/39/3/1: Stock and game farming: promotion of the combating of proclaimed weeds in the veld in the Somerset East Extension Ward. 1985. J.C. van Aardt

K.6211/39/3/2: Stock and game farming: promotion of the combating of proclaimed weeds in the Graaff-Reinet Extension Ward. 1980. J.G. Theron

N.6211/39/1/1: Stock and game farming: the promotion of cultivated pastures in the Dundee Extension Ward. 1984. B.N. Genlloud

N.6211/39/1/2: Stock and game farming: the promotion of cultivated pastures in the Howick Extension Ward. 1981. R.N. Webster

N.6211/39/1/3: Stock and game farming: the promotion of cultivated pastures in the Ixopo Extension Ward. 1985. M.J. Pereira da Conceico

N.6211/39/1/4: Stock and game farming: the promotion of cultivated pastures in the Kokstad Extension Ward. 1985. G.P. Devereux

N.6211/39/1/5: Stock and game farming: the promotion of cultivated pastures in the Underberg Extension Ward. 1985. C.M. Allan

N.6211/39/2/1: Stock and game farming: the promotion of improved veld management practices in the Weenen conservation district. 1974. S.K. Armour

N.6211/39/2/2: Stock and game farming: the promotion of improved veld management practices in the Muden area of the Umvoti magisterial district. 1979. K.G. Camp

N.6211/39/3/1: Stock and game farming: the persuasion of farmers to control *Rubus cuneifolius* in the Howick Extension Ward. 1981. R.M. Webster

N.6211/39/4/1: Stock and game farming: the promotion of dairy farming in the Ixopo Extension Ward. 1985. M.J. Pereira da Conceico

N.6211/39/5/1: Stock and game farming: the promotion of grazing and animal management practices in the Underberg conservation area. 1986. C.M. Allan

V.6211/39/1/1: Stock and game farming: the persuasion of stock farmers in the Molopo Extension Ward to contain bush encroachment. 1985. M.J. van den Heever

V.6211/39/1/2: Stock and game farming: the persuasion of stock farmers in the Molopo Extension Ward to adopt improved grazing and stock farming practices. 1985. M.J. van den Heever

V.6211/39/1/3: Stock and game farming: the persuasion of stock farmers in the Molopo Extension Ward to keep farming records and to adopt financial management practices. 1985. M.J. van den Heever

V.6211/39/1/4: Stock and game farming: the persuasion of demonstrator farmers to determine the grazing potential of grazing capacity zones in the Molopo Extension Ward. 1985. M.J. van den Heever

V.6211/39/2/1: Stock and game farming: the persuasion of stock farmers in the Postmasburg Extension Ward to contain bush encroachment. 1985. L.J. de Jager

V.6211/39/2/2: Stock and game farming: the determination of veld and stock management practices in the Postmasburg Extension Ward. 1985. L.J. de Jager

V.6211/39/2/3: Stock and game farming: the persuasion of stock farmers in the Postmasburg Extension Ward to keep farming records and to adopt financial management practices. 1985. L.J. de Jager

V.6211/39/2/4: Stock and game farming: the persuasion of demonstrator farmers to determine the grazing potential of grazing capacity zones in the Postmasburg Extension Ward. 1985. L.J. de Jager

V.6211/39/3/1: Stock and game farming: the determination of physic field factors which have an influence on the application of veld management systems. 1985. G.P. Nel

V.6211/39/4/1: Stock and game farming: the persuasion of stock farmers in the Brandfort Extension Ward to change their attitude towards veld management. 1985. H. Putter

V.6211/39/4/2: Stock and game farming: the persuasion of stock farmers in the Brandfort Extension Ward to adopt radical veld improvement practices. 1985. H. Putter

V.6211/39/4/3: Stock and game farming: the persuasion of stock farmers in the Brandfort Extension Ward to have their farms planned. 1985. H. Putter

V.6211/39/4/4: Stock and game farming: the persuasion of stock farmers in the Brandfort Extension Ward to adopt sound veld management practices. 1985. H. Putter

V.6211/39/4/5: Stock and game farming: the persuasion of stock farmers in the Brandfort Extension Ward to develop a fodder flow programme annually and to implement it. 1985. H. Putter

V.6211/39/4/6: Stock and game farming: the persuasion of stock farmers in the Brandfort Extension Ward to keep farming records and to adopt financial management practices. 1985. H. Putter

V.6211/39/5/1: Stock and game farming: the persuasion of stock farmers in the Theunissen Extension Ward to change their attitude towards veld management. 1985. H. Putter

V.6211/39/5/2: Stock and game farming: the persuasion of stock farmers in the Theunissen Extension Ward to adopt radical veld improvement practices. 1985. H. Putter

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V.6211/39/5/5: Stock and game farming: the persuasion of stock farmers in the Theunissen Extension Ward to develop a fodder flow programme annually and to implement it. 1985. H. Putter

V.6211/39/5/6: Stock and game farming: the persuasion of stock farmers in the Theunissen Extension Ward to keep farming records and to adopt financial management practices. 1985. H. Putter

V.6211/39/6/1: Stock and game farming: the persuasion of sheep farmers in the Edenburg Extension Ward to adopt improved grazing and stock farming practices. 1985. J.H. Venter

V.6211/39/6/2: Stock and game farming: the determination of the grazing potential in the grazing capacity zones of the Edenburg Extension Ward. 1985. J.H. Venter

V.6211/39/6/3: Stock and game farming: the persuasion of stock farmers in the Edenburg Extension Ward to establish perennial cultivated pastures. 1985. J.H. Venter

V.6211/39/6/4: Stock and game farming: the persuasion of stock farmers in the Edenburg Extension Ward to keep farming records and to adopt financial management practices. 1985. J.H. Venter

V.6211/39/7/1: Stock and game farming: the persuasion of farmers in the "Duineveld" of Upington North Extension Ward to adapt their stock numbers according to available grazing. 1985. N.J. de Wet

V.6211/39/7/2: Stock and game farming: to make the farmers aware of the reproduction losses and mortality of mutton sheep. 1985. N.J. de Wet

V.6211/39/7/3: Stock and game farming: to demonstrate the influence of energy supplementary feeding on the performance of mutton sheep ewes in the Upington North Extension Ward. 1985. N.J. de Wet

V.6211/39/7/4: Stock and game farming: to identify "top farmers" in the Upington North Extension Ward and stipulate privileges and recognition for them. 1985. N.J. de Wet

V.6211/39/7/5: Stock and game farming: the persuasion of farmers in the Upington North Extension Ward towards better stock practices by means of the demonstration farm, Massakloutjie. 1985. N.J. de Wet

W.6211/39/1/1: Stock and game farming: persuasion of farmers in the Oudtshoorn Extension Ward to establish and utilise drought resistant forage crops. 1985. C.J. Nel

W.6211/39/1/2: Stock and game farming: persuasion of small stock farmers in the Montagu Extension Ward to cultivate and utilise drought resistant forage and dryland pastures. 1985. E.J.J. Nel

W.6211/39/1/3: Stock and game farming: persuasion of stock farmers in the Ladismith Extension Ward to establish and utilise drought resistant forage crops and dryland pasture as well as the establishment of Karoobush seed plots for veld reinforcement. 1985. C.F. Scholtz

W.6211/39/2/1: Stock and game farming: persuasion of small stock farmers in the Vredendal Extension Ward to apply improved grazing management practices based on knowledge of natural grazing plants and their physiological needs. 1985. G. Louw

W.6211/39/2/2: Stock and game farming: persuasion of farmers in the Vredendal Extension Ward to establish drought forage crops. 1985. G. Louw

W.6211/39/3/1: Stock and game farming: persuasion of irrigation farmers in the Swellendam Extension Ward to implement optimal use of established pastures in their dairy fodder flow programmes. 1985. J.P. Pietersen

W.6211/39/3/2: Stock and game farming: persuasion of farmers in the Riversdal Extension Ward to improve the profitability of their dairy herds through the evaluation and interpretation of physical/financial record-keeping results. 1985. J.W. du Preez

W.6211/39/3/3: Stock and game farming: persuasion of stock farmers in the Bredasdorp Extension Ward to apply chemical control of annual invader grasses in their dryland legume pastures. 1985. D. Cronjé

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W.6211/39/3/5: Stock and game farming: the persuasion of stock farmers in the Swellendam Extension Ward to apply chemical control of annual invader grasses in their dryland legume pastures. 1985. J.P. Pietersen

W.6211/39/4/1: Stock and game farming: persuasion of sheep farmers in the Malmesbury Extension Ward to implement management practices that would lead to higher weaning percentages. 1985. J.H.F. Roelofse

W.6211/39/5/1: Stock and game farming: persuasion of dairy farmers in the Durbanville Extension Ward to apply improved management techniques. 1985. G.J. Joubert

W.6211/39/6/1: Stock and game farming: persuasion of farmers in the Olifantsrivier-Gamka farming area to improve their management and utilisation of lucerne. 1985. B.F.A. Visser

- *Management/Bestuur*

N.6211/41/1/1: Stock and game farming: analysis of beef production management systems in the Underberg Extension Ward. 1985. C.M. Allan

N.6211/41/1/2: Stock and game farming: the analysis of stock and game management systems on veld in the Pongola Extension Ward. 1986. D.M. Gammon

- *Modelling/Modellering*

N.6211/42/1/1: Stock and game farming: development of a beef feeding simulator programme. 1975. B.J. Lyle

N.6211/42/1/2: Stock and game farming: development of a dairy herd computer simulator programme. 1975. P.G. Stewart

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N.6211/42/1/5: Stock and game farming: fodder production planning for farming units. 1976. R.I. Jones

N.6211/42/1/6: Stock and game farming: development of micro-computer programmes for dairy herd management. 1981. R.I. Jones

• *Chemical control/Chemiese beheer*

N.6212/21/1/1: Crop farming: insect pests of maize and their control. 1986. R.A. Bell

• *Persuasion/Oorreding*

K.6212/39/2/1: Crop farming: persuasion of farmers to practise optimal irrigation management and techniques in the Cradock Extension Ward. 1984. P.S. van Heerden

K.6212/39/2/2: Crop farming: persuasion of farmers to practise optimal irrigation management and techniques in the Somerset East Extension Ward. 1984. P.S. van Heerden

N.6212/39/1/1: The promotion of improved crop farming practices in the Winterton conservation area. 1976. S.D. le Roux

W.6212/39/1/3: Crop farming: persuasion of farmers in the George Extension Ward to incorporate lupins as a crop in their farming systems. 1985. W.G.J. Voigt

W.6212/39/2/1: Crop farming: persuasion of farmers in the Piketberg Extension Ward to apply improved small grain production techniques. 1985. B.F. Saaiman

W.6212/39/2/2: Crop farming: persuasion of farmers in the Moorreesburg area of jurisdiction to raise the profitability of farming by the use of physical financial management information. 1985. W. Burger

W.6212/39/2/3: Crop farming: persuasion of farmers in the Moorreesburg Extension Ward to apply improved weed control techniques. 1986. I.F. Slabbert

W.6212/39/3/1: Crop farming: persuasion of farmers in the Worcester Extension Ward to adopt improved practices aimed at raising the unit production of irrigated wheat. 1985. D.J. Kemp

MIXED FARMING/GEMENGDE BOERDERY

• *Persuasion/Oorreding*

D.6213/39/1/1: Mixed farming: to persuade crop farmers in the Alexandria Extension Ward to adopt optimal crop production systems. 1986. A.E. du Plessis

D.6213/39/1/2: Mixed farming: to persuade farmers in the Alexandria ward to implement the water run-off control plans drawn up for their farms. 1987. A.E. du Plessis

D.6213/39/1/3: Mixed farming: the training of extension personnel in the east coast and central subregions with regard to economic principles and concepts and their practical application. 1987. J.F. Els

D.6213/39/1/4: Mixed farming: to persuade landowners to effectively protect their lands which are situated above the Gamtoos State Water Scheme and for which run-off control programmes were served. 1987. H.J. Smith

D.6213/39/1/5: Mixed farming: optimal resource development of the irrigation area in the Hankey magisterial district. 1987. H.J. Els

H.6213/39/1/1: Persuasion of farmers with mixed farming enterprises in the Bethlehem Extension Ward in order to promote optimal land utilisation. 1981. J.H. de Klerk

H.6213/39/1/2: Persuasion of farmers with mixed farming enterprises in the Harrismith Extension Ward in order to promote optimal land utilisation. 1983. J.T. van Rooyen

H.6213/39/1/3: Persuasion of farmers with mixed farming enterprises in the Kroonstad Extension Ward in order to promote optimal land utilisation. 1981. P.J. van Wyk

H.6213/39/1/4: Persuasion of farmers with mixed farming enterprises in the Bothaville Extension Ward in order to promote optimal land utilisation. 1979. J.I. de V. Burger

H.6213/39/1/5: Persuasion of farmers with mixed farming enterprises in the Parys Extension Ward in order to promote optimal land utilisation. 1981. A.G.H. Kotzé

H.6213/39/1/6: Persuasion of farmers with mixed farming enterprises in the Klerksdorp Extension Ward in order to promote optimal land utilisation. 1981. C.F. van Eeden

H.6213/39/1/7: Persuasion of farmers with mixed farming enterprises in the Lichtenburg subregion in order to promote optimal land utilisation. 1982. M.M. Grobbelaar

H.6213/39/1/8: Persuasion of farmers with mixed farming enterprises in the Heidelberg subregion in order to promote optimal land utilisation. 1978. C.C.A. Breed

H.6213/39/1/9: Persuasion of farmers with mixed farming enterprises in the Wolmaransstad Extension Ward in order to promote optimal land utilisation. 1986. A.J. Loretz

H.6213/39/1/10: Persuasion of farmers with mixed farming enterprises in the Potchefstroom Extension Ward in order to promote optimal land utilisation. 1986. J.J. Steyn

N.6213/39/1/1: The promotion of optimum production based on resource planning in the Pietermaritzburg Extension Ward. 1986. G. McGrath

T.6213/39/1/1: Mixed farming: the persuasion of farmers to practise optimal resource utilisation in the high rainfall sourveld area of Belfast. 1985. A. van Deventer

T.6213/39/2/1: Mixed farming: situation analysis of the irrigation practices in the Groblersdal Extension Ward. 1986. M.G. du Toit

T.6213/39/3/1: Mixed farming: situation analysis of the peach industry in the Silverton Extension Ward. 1986. J.B. Stevens

T.6213/39/3/2: Mixed farming: determination of a benchmark of the peach industry by means of case studies in the Silverton Extension Ward. 1986. J.B. Stevens

T.6213/39/3/3: Mixed farming: training of peach farmers in the implementation of adopted practices. 1987. J.B. Stevens

V.6213/39/1/1: Mixed farming: the persuasion of stock farmers in the Mafeking Extension Ward to contain bush encroachment. 1985. W. Goldblatt

V.6213/39/1/2: Mixed farming: the persuasion of stock farmers in the Mafeking Extension Ward to adopt improved grazing and stock farming practices. 1985. W. Goldblatt

V.6213/39/1/3: Mixed farming: the persuasion of stock farmers in the Mafeking Extension Ward to keep farming records and to adopt financial management practices. 1985. W. Goldblatt

V.6213/39/1/4: Mixed farming: the persuasion of demonstrator farmers to determine the grazing potential of grazing capacity zones in the Mafeking Extension Ward. 1985. W. Goldblatt

V.6213/39/1/5: Mixed farming: the persuasion of demonstrator farmers to develop economic methods for the eradication of sandgeelhout invader plants. 1985. W. Goldblatt

W.6213/39/1/1: Mixed farming: persuasion of farmers in the Oudtshoorn Extension Ward to implement improved fertilisation, irrigation and drying practices of tobacco. 1985. B.F.A. Visser

- *Norm studies/Normstudies*

D.6213/50/1/1: Mixed farming: collection and processing of pasture and animal production data for use in dairy production. 1986. P.J. Olivier

D.6213/50/1/2: Mixed farming: collection and processing of pasture and animal production data for use in small stock production. 1986. J.C. Scheltema

FRUIT FARMING/VRUGTEBOERDERY

- *Situation analysis/Situasiebepaling*

N.6214/35/1/1: Situation analysis: bananas in the Port Shepstone Extension Ward. 1983. E.H. Gevers

• *Persuasion/Oorreding*

N.6214/39/1/1: Fruit farming: the promotion of efficient pineapple production techniques in the Natal eastern seaboard area at Hluhluwe. 1986. E.H. Gevers

T.6214/39/1/1: Fruit farming: the persuasion of guava farmers to optimal resource utilisation in the irrigation areas of the Lowveld. 1982. J.J. Kruger

T.6214/39/1/2: The persuasion of banana producers to optimal resource utilisation in the irrigation areas of the Transvaal Lowveld. 1983. C.C. Engelbrecht

W.6214/39/1/1: Fruit farming: persuasion of farmers in the Langkloof farming area to implement recommended soil-plant combinations, correct soil preparation and established techniques. 1985. W.S. van der Merwe

W.6214/39/2/1: Fruit farming: persuasion of farmers in the Ceres Extension Ward to apply effective control of codling moth on pome fruit. 1985. P.W. Immelman

VEGETABLE FARMING/GROENTEBOERDERY

• *Persuasion/Oorreding*

W.6215/39/1/1: Vegetable farming: persuasion of onion farmers in the Caledon Extension Ward to implement improved farming techniques. 1985. C.L. van Rooyen

VITICULTURE/WINGERDBOERDERY

• *Persuasion/Oorreding*

W.6216/39/1/1: Viticulture: persuasion of farmers in the Vredendal Extension Ward to apply correct techniques of winter pruning and manipulation of summer foilage. 1985. S. Lutz

W.6216/39/1/2: Viticulture: persuasion of farmers in the Vredendal Extension Ward to apply updated techniques of irrigation. 1986. P.B. van der Merwe

W.6216/39/2/1: Viticulture: persuasion of farmers in the Amalienstein/Van Zylsdamme farming area to implement optimal irrigation techniques. 1985. M.J. de W. Delport

W.6216/39/3/1: Viticulture: persuasion of farmers in the Mamalienstein/Van Zylsdamme farming area to implement recommended soil-plant combinations, correct soil preparation and establishment techniques for perennial crops. 1985. M.J. de W. Delport

W.6216/39/3/2: Viticulture: persuasion of farmers in the irrigation areas of Montagu Extension Ward to implement recommended soil-crop combinations, correct soil preparation and establishment techniques for perennial crops. 1985. W.J. Basson

W.6216/39/4/1: Viticulture: persuasion of farmers in the Wellington Extension Ward to implement scientifically founded establishment practices for perennial crops. 1985. W.J.K. Ferreira

AGRICULTURAL ENGINEERING SERVICES
LANDBOU-INGENIEURSDIENSTE

Agricultural mechanisation/Landboumeganisasie

POWER SOURCES AND LABOUR/KRAGBRONNE EN ARBEID

• *Engineering/Ingenieurskunde*

LI.6711/51/1/1: Evaluation of tractor characteristics - power take-off shaft and safety frames. 1982. J.J.P.C. Swanepoel

LI.6711/51/1/2: Power sources and labour: performance of two-wheel, four-wheel and crawler track-driven tractors under a variety of conditions. 1981. R.W. Otterman

AGRICULTURAL IMPLEMENTS/LANDBOUWERKTUIE

- *Engineering/Ingenieurskunde*

LI.6712/51/1/1: Engineering aspects of agricultural machinery. 1982. A.J. Heyns

Agricultural structures and facilities/Landboustrukture en -fasiliteite

CLIMATE-CONTROLLED STRUCTURES/KLIMAATBEHEERDE STRUKTURE

- *Engineering/Ingenieurskunde*

LI.6722/51/1/1: Engineering aspects of climatic-controlled structures. 1982. P.J. Britz

STOCK HOUSING AND FACILITIES/VEEBEHUISING EN -FASILITEITE

- *Engineering/Ingenieurskunde*

LI.6723/51/1/1: Engineering aspects of animal housing and facilities. 1982. P.A. Henning

LI.6723/51/1/2: Engineering aspects of animal housing and related facilities in the Winter Rainfall Region. 1982. J.C. Venter

Irrigation and drainage engineering/Besproeiings- en dreineringsingenieurswese

IRRIGATION/BESPROEIING

- *Engineering/Ingenieurskunde*

LI.6731/51/1/1: Engineering aspects of irrigation. 1982. F.B. Reinders

DRAINAGE/DREINERING

- *Engineering/Ingenieurskunde*

LI.6732/51/1/1: Engineering aspects of sub-surface drainage systems. 1982. F.J.C. Hugo

BOTANY/BOTANIE

BOTANY RESEARCH/BOTANIESE NAVORSING

Plant taxa/Planttaksons

FLORA

- *Taxonomy/Taksonomie*

PL.7111/01/1/6: Flora of southern Africa: Liliaceae - Dracaenoideae and Asparagoideae. 1979. G.E. Gibbs Russell

PL.7111/01/1/7: Flora of southern Africa: Ericaceae - minor genera. 1970. E.G.H. Oliver

PL.7111/01/1/11: Flora of southern Africa: Mesembryanthemaceae - Ruschiinae. 1977. H.F. Glen

PL.7111/01/1/14: Flora of southern Africa: Bryophyta. 1976. J. van Rooy

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PL.7111/01/1/19: Flora of southern Africa: Restionacae. 1981. H.P. Linder

PL.7111/01/1/20: Flora of southern Africa: the tribe Desmodiae (Fabaceae - Papillonoideae). 1981. B.D. Schrire

PL.7111/01/1/21: Flora of southern Africa: Orchidaceae. 1981. O.A. Leistner

PL.7111/01/1/23: Flora of southern Africa: Salicaceae, Fabaceae, Urticaceae and Piperaceae. 1984. K.L. Immelman

PL.7111/01/1/24: Flora of southern Africa: the tribe Tephrosieae (Fabaceae - Papillonoideae). 1985. B.D. Schrire

PL.7111/01/1/26: Flora of southern Africa: Liliaceae - Aloineae - *Aloe*. 1985. H.F. Glen

PL.7111/01/1/27: Flora of southern Africa: the tribe Indigofereae (Fabaceae-Papillionoideae). 1987. B.D. Schrire

PL.7111/01/1/28: Flora of southern Africa: Lythraceae, Lecythidaceae and Rhizophoraceae. 1987. K.L. Immelman

PL.7111/01/2/1: Illustrated flora of the Pretoria region. 1973. O.A. Leistner

PL.7111/01/2/2: Regional flora: Transvaal wild flowers (Vol. 2). 1984. G. Germishuizen

PL.7111/01/2/3: Flora of Namaqualand. 1987. G.E. Gibbs Russell

PL.7111/01/3/1: Pretoria National Herbarium Computerised Information System (PRECIS) for the flora of southern Africa: Specimen Database. 1986. G.E. Gibbs Russell

PL.7111/01/3/2: Pretoria National Herbarium Computerised System (PRECIS) for the flora of southern Africa: Taxon Database. 1986. G.E. Gibbs Russell

PL.7111/01/3/3: Pretoria National Herbarium Computerised Information System (PRECIS) for the flora of southern Africa: Nomenclatural Database. 1986. G.E. Gibbs Russell

ANGIOSPERMAE

- *Taxonomy/Taksonomie*

PL.7112/01/1/1: Taxonomy of Angiospermae: the family Polygonaceae. 1979. T.H. Arnold

PL.7112/01/1/3: Taxonomy of Angiospermae: the genus *Ficinia* (section Bracteosae). 1976. G. Germishuizen

PL.7112/01/1/5: Taxonomy of Angiospermae: the genus *Justicia* in southern Africa. 1982. K.L. Immelman

PL.7112/01/1/6: Taxonomy of Angiospermae: the role of fruit seed and seedling characters in the classification of Cucurbitaceae in southern Africa. 1983. E. Retief

PL.7112/01/1/7: Taxonomy of Angiospermae: the genus *Vigna* Savi in southern Africa. 1984. B.J. Pienaar

PL.7112/01/1/8: Taxonomy of Angiospermae: the genus *Carex* L. in southern Africa. 1985. C. Reid

PL.7112/01/1/9: Taxonomy of Angiospermae: the broad-leaved species of the genus *Asclepias* L. in southern Africa. 1986. A. Nicholas

PL.7112/01/2/1: Biosystematics of Angiospermae: the *Eragrostis curvula* complex. 1972. B. de Winter

PL.7112/01/2/2: A phenological, ontogenetical and cytogenetical study of the *Digitaria eriantha* complex of the Angiospermae. 1987. J.J. Spies

PL.7112/01/3/1: Angiospermae: flowering plants of Africa. 1921. D.J.B. Killick

• *Anatomy/Anatomie*

PL.7112/02/1/1: Comparative anatomy of the angiosperm subfamily Arundinoideae. 1972. R.P. Ellis

PL.7112/02/1/2: Comparative anatomy of the angiosperm subfamily Bambusoideae. 1972. R.P. Ellis

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PL.7112/02/1/4: Comparative anatomy of the angiosperm subfamily Panicoideae. 1972. R.P. Ellis

PL.7112/02/1/5: Comparative anatomy of the angiosperm subfamily Eragrostoideae. 1972. R.P. Ellis

PL.7112/02/1/8: Development of a leaf-tensilmeter for measuring fibre-related leaf tensile strength and application thereof for determining palatability of grasses (Angiospermae). 1986. R.H. Westfall

PL.7112/02/2/1: Morphological and anatomical survey of the wood and bark of southern African woody Angiospermae. 1984. P.P.J. Herman

PL.7112/02/2/2: The application of wood anatomical information of the southern African woody Angiospermae to dendrochronology, wood technology, tree physiology and florensic science. 1984. P.P.J. Herman

• *Genetics/Genetika*

PL.7112/06/1/1: Cytotaxonomic studies of Angiospermae: the genus *Sorghum*. 1983. J.J. Spies

PL.7112/06/2/1: Karyotype studies of the Angiosperm family Poaceae: the subfamily Arundinoideae. 1983. J.J. Spies

PL.7112/06/2/2: Karyotype studies of the Angiosperm family Poaceae: the subfamily Bambusoideae. 1983. J.J. Spies

PL.7112/06/2/3: Karyotype studies of the Angiosperm family Poaceae: the subfamily Festucoideae. 1983. J.J. Spies

PL.7112/06/2/4: Karyotype studies of the Angiosperm family Poaceae: the subfamily Panicoideae. 1983. J.J. Spies

PL.7112/06/2/5: Karyotype studies of the Angiosperm family Poaceae: the subfamily Chloridoideae. 1983. J.J. Spies

• *Plant geography/Plantgeografie*

PL.7112/25/1/3: Final distribution atlas of the woody Angiospermae of the Transvaal. 1979. J.M. Anderson

BRYOPHYTA

- *Taxonomy/Taksonomie*

PL.7115/01/1/1: Bryophyta: the ultrastructure of the wall ornamentation as a taxonomic aid in identifying the species of the genus *Riccia* (Hepaticae) in southern Africa. 1981. S.M. Perold

PL.7115/01/1/2: Taxonomy of Bryophyta: the family Ricciaceae Dum. (Hepaticae) in southern Africa. 1987. S.M. Perold

LICHENS/LIGENE

- *Taxonomy/Taksonomie*

PL.7116/01/1/1: Miscellaneous taxonomic studies on southern African lichens. 1987. F.A. Brusse

FOSSIL PLANTS/FOSSIELPLANTE

- *Taxonomy/Taksonomie*

PL.7118/01/1/1: The fossil plants of the Upper Triassic Molteno Formation in South Africa. 1978. J.M. Anderson

Vegetation/Plantegroei

FOREST/WOUD

- *Ecology/Ekologie*

PL.7121/27/1/1: Vegetation study of the Zululand coastal dunes, including forest, between Richards Bay and Mlalazi Lagoon. 1980. P.J. Weisser

PL.7121/27/1/2: Coast forest biome: conservation priorities in the dune area between Kosi Bay and Sodwana based on a vegetation survey. 1985. P.J. Weisser

PL.7121/27/2/1: A regional plant-ecological study of forests, woodlands and grasslands of the north-eastern mountain sourveld (and adjacent lowveld sour bushveld) in the Sabie area of the Eastern Transvaal escarpment. 1982. G.B. Deall

BUSHVELD/BOSVELD

- *Ecology/Ekologie*

PL.7122/27/1/1: Seasonal growth of woody bushveld plants in the Nylsvley *Burkea* Savanna Ecosystem Project. 1975. M.C. Rutherford

PL.7122/27/2/1: The plant ecology of the bushveld farm Groothoek, Thabazimbi district. 1980. R.H. Westfall

PL.7122/27/2/2: The vegetation ecology of sour bushveld in the Transvaal Waterberg. 1984. R.H. Westfall

FYNBOS

- *Ecology/Ekologie*

PL.7123/27/1/1: Vegetation transects through the Western Cape lowland fynbos. 1977. J.C. Scheepers

PL.7123/27/1/2: A semi-detailed regional ecological study of the Western Cape lowland fynbos. 1970. J.C. Scheepers

PL.7123/27/1/3: A plant-ecological study of the fynbos and other vegetation in the southern Cape coastal foreland. 1985. J.C. Scheepers

PL.7123/27/2/3: The fynbos communities of Swartboschkloof, Jonkershoek. 1982. D.J. MacDonald

PL.7123/27/2/4: A plant-ecological study of the fynbos and other vegetation in mountain catchments of the Langeberg, South-western Cape. 1984. D.J. MacDonald

PL.7123/27/2/5: An ecological study of mountain fynbos in the Cedarberg. 1984. H.C. Taylor

PL.7123/27/3/1: An ecophysiological study of fynbos seedling development under competitive stress with invasive alien acacias. 1982. F.M. Pressinger

PL.7123/27/3/2: Relative productive capacities of species populations following fire in indigenous alien mixed plant communities in the fynbos biome. 1984. C.F. Musil

PL.7123/27/3/3: Survival of fynbos plants in areas severely invaded by alien plant species. 1984. M.C. Rutherford

GRASSLAND/GRASVELD

• *Ecology/Ekologie*

PL.7124/27/1/1: A plant-ecological study of the grassland and other vegetation in the Amersfoort area of Eastern Transvaal highveld. 1984. B.J. Turner

PL.7124/27/1/2: A plant-ecological study of the grassland and other vegetation in the Grootvlei area of the Highveld Region. 1984. J.C. Scheepers

KAROO

• *Ecology/Ekologie*

PL.7125/27/1/1: Water-use efficiencies of the main plant life forms in the western Karoo. 1984. G.F. Midgley

PL.7125/27/2/1: A reconnaissance study of the Karoo and other vegetation in the Graaff-Reinet and Middelburg areas of the eastern Karoo Region. 1987. A.R. Palmer

AQUATIC VEGETATION/AKWATIESE PLANTEGROEI

• *Ecology/Ekologie*

PL.7126/27/1/2: Study of the aquatic vegetation of the Cape estuaries from the Kei River to the Orange River. 1981. M.G. O'Gallaghan

NATURALISED VEGETATION/NATUURLIKE PLANTEGROEI

• *Genetics/Genetika*

PL.7127/06/1/1: Naturalised vegetation: a cytotaxonomic study of *Lantana camara* in southern Africa. 1979. J.J. Spies

PL.7127/06/1/2: Naturalised vegetation: cytotaxonomy of *Rubus* in South Africa. 1975. J.J. Spies

• *Ecology/Ekologie*

PL.7127/27/1/2: Naturalised vegetation: review of knowledge of nassella tussock grass. 1972. M.J. Wells

• *Evaluation/Evaluasie*

PL.7127/37/1/1: Naturalised vegetation: compilation and maintenance of a national weed list. 1979. M.J. Wells

AFRICAN VEGETATION/AFRIKAANSE PLANTEGROEI

• *Ecology/Ekologie*

PL.7128/27/1/2: African vegetation: a plant-ecological bibliography for southern Africa from 1976 to 1980. 1976. A.P. Backer

PL.7128/27/2/1: African vegetation: a revision of the Karoid and adjoining veld types. 1945. J.C. Scheepers

PL.7128/27/2/2: African vegetation: an objective categorisation of the biomes of southern Africa. 1984. M.C. Rutherford

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Valuable veld plants/Waardevolle veldplante

FOOD PLANTS/VOEDSELPLANTE

• *Taxonomy/Taksonomie*

PL.7131/01/1/1: A preliminary investigation of the taxonomy and economic importance of food plants of African origin. 1979. T.H. Arnold

• *Potential studies/Potensiaalstudies*

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OTHER USEFUL PLANTS/ANDER NUTTIGE PLANTE

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SUPPORTING AND ASSOCIATED SERVICES
ONDERSTEUNENDE EN VERWANTE DIENSTE

BIOMETRIC AND DATAMETRIC SERVICES
BIOMETRIESE EN DATAMETRIESE DIENSTE

Biometric services/Biometriese dienste

ANALYTIC TECHNIQUES/ONTLEDINGSTEGNIEKE

- *Biometry/Biometrie*

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